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The Effects of Airline Deregulation on Airline Safety: An Econometric Analysis

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THE EFFECTS OF AIRLINE DEREGULATION ON AIRLINE SAFETY:

AN ECONOMETRIC ANALYSIS

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After an unfortunate series of accidents in the mid 1930's the Air Transport Association (ATA) lobbied Congress for regulation of the industry. The ATA claimed that unfair

competition was endangering the public safety. The Civil Aeronautics Act of 1938 created the Civil Aeronautics Board (CAB) and gave the CAB the authority to regulate the industry. During the regulation era airline ridership increased and safety improved.

During the regulation period, opportunity for comparing the safety record of the regulated industry with the record of the unregulated portions of the industry was limited. The few attempts made rendered inconclusive results.

During a period of high inflation and high interest rates in the 1970's interest in deregulating the airlines arose. With passage of the Airline Deregulation Act of 1978, interest in the effects of regulation on airline safety was renewed. More than a decade has passed since deregulation. The industry has continued to improve its safety record during the deregulation period. The question remains: "How has deregulation affected airline safety?".

In this study records of airline accidents and incidents investigated by the National Transportation Safety Board are examined. The occurrences are divided into those with causes that are under the airlines control and those that are not under their control. Those under the airlines control are regressed against time and a dummy variable for deregulation. The possible effects of airline profitability on the results, are also explored.

The results indicate that deregulation had an adverse effect on airline safety. The effects of alternative formulations are also examined. The effect though statistically significant is small. It does not suggest the need to return to a regulated airline industry. But, it does suggest the need for additional research into the connection between airline safety and competition.

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CHAPTER I

INTRODUCTION

Since the beginning of the history of flight, air safety has been a concern. We are told that Daedalus briefed Icarus on flight safety as part of the preflight preparation before aviation's "first" fatal accident (Bulfinch, 1947: 156).

This concern for aviation safety was part of the impetus for the regulation of the airline industry in the 1930's. The Civil Aeronautics Act was passed in 1938 after an unfortunate series of accidents and allegations of impropriety in the airmail and airline industry. Senator Bronson Cutting and four others died in the crash of a TWA Skychief in Missouri in May 1935. Wiley Post and Will Rogers died just three months later. These accidents damaged public faith in the industry and demonstrated the limitations present in aviation (Whitnah, 1966: 116).

Providing a safe airline is an expensive proposition. Preventative maintenance; redundancy of important instruments and controls; and training of aircrews, maintenance personnel, and cabin attendants are all expensive. Established airlines were right to fear price competition from new entries that might not be as conscious of safety. They also were right to fear the adverse public perception of the airline industry caused by aircraft accidents.

The airlines formed the Air Transport Association of America in 1936 to lobby Congress for regulation. The 1938 Act created the independent regulatory agency, the Civil Aeronautics Board (CAB). The Act gave the CAB authority to control entry into and exit from markets (routes). The CAB was also authorized to regulate fares, to award subsidies, to control mergers and to regulate safety.

Economic regulation and the resultant limits to competition are generally viewed as advantageous by the industry being regulated. As Jordan shows in Airline Regulation in America: Effects and Imperfections, regulation protects producers by helping them form a cartel to obtain monopoly benefits. These benefits include limiting entry so that relatively fewer firms exist. Exit would also be controlled so that the market share of an exiting firm would accrue to one or more of the remaining firms. Higher price levels would be expected. The U.S. airline industry fit this description during the regulation era (Jordan, 1970: 49).

Economic regulation provided an environment that fostered growth and high safety levels in the U.S. airline industry. The domestic trunks flew 3.3 million revenue passenger miles (RPM) in 1945. By 1975 this had increased to 119 million RPM (Bailey, Graham and Kaplan, 1985: 204,5). This increase was accompanied by a corresponding decrease in accident rates.

During the seventies, the political climate turned in favor of deregulation of the transportation industry. Inflation was a major impetus in airline deregulation. The prevailing economic theory indicated that deregulation should have a positive effect. Deregulation was expected to result in lower fares and increases in passenger travel.

STATEMENT OF THE PROBLEM

The problem addressed by this study concerns the relationship between economic regulation of the airline industry and air safety. Specifically the study will address the effect on air safety of the Airline Deregulation Act of 1978.

It is certain that safety has continued to improve since the beginning of the deregulation era. However, the question is, has safety improved as much as it would have if the industry were still regulated?

Note also that safety may have been over-provided during the regulation era. The appropriate economic goal for regulators is optimum safety not maximum safety. The optimum level of safety is reached when an additional increment of safety would cost more than the resulting benefit to society in decreased risk. This level might be different for different consumers. Given the opportunity, more risk-adverse consumers might opt for higher levels of safety than their less risk-adverse counterparts.

Transportation consumers might not be willing to pay for the "optimum" level of safety. There may be third party who are affected by the transportation consumers' decisions. Air travel consumers may not be willing to pay for these third parties' needs.

The possibility that safety was over-provided will not be addressed in this study. Nor will I try to establish what the optimum level of safety might be.

A safe airline operation is in everyone's best interest, but safety has a concomitant cost. An airline's profitability might affect its ability to cover this cost. To the extent that this is true, deregulation may have had a positive effect on airline safety. This would be the case if deregulation had a positive effect on airline profitability, and this positive effect on airline profitability had, in turn, a positive effect on safety expenditures.

The Null Hypothesis

The Null Hypothesis will be that "Economic deregulation of the airlines has had no effect on airline safety."

SIGNIFICANCE OF THE STUDY

The cost to society of even one major aircraft accident is tremendous. Modern airliners, in addition to being very expensive, are capable of carrying several hundred passengers. The potential loss of even one aircraft with its passengers and crew is terrible. Under regulation the airline industry's safety record was a very good and improving one. There is no clear evidence that the airlines' safety record has deteriorated greatly under deregulation. There is, however, no clear, quantifiable basis for decision making concerning economic regulation and air safety. Comparing the safety record of the airline industry prior to, and since deregulation could establish this basis. The results of such an analysis could significantly enhance the knowledge of the relationship between economic regulation and safety. This would thus advance the economic theory of regulation and provide information needed to make regulatory decisions.

It should be noted here that finding a mathematical correlation between regulation/deregulation and airline safety does not establish a causal relationship. Finding a significant correlation between deregulation and safety merely establishes the possibility of a relationship. The nature of the relationship must be determined by the use of some other theoretical construct. Some possible mechanisms whereby the economic impact of deregulation might affect safety will be explored in this project; the main thrust is still to determine if such a correlation exists.

Establishing a correlation between deregulation and safety is an important first step in establishing a relationship. If no significant correlation is found, any relationship that exists must be very slight assuming that the model is properly formulated. That is, such a relationship could be masked by factors that were not considered or it could be too small to be detected. Every effort will be made to eliminate the effects of other variables so that negative findings will indicate that any relationship remaining to be found is too small to be significant.

CHAPTER II

THE LITERATURE

THE HISTORY OF REGULATION

Early History

The airlines formed the Air Transport Association of America in 1936 to lobby Congress for regulation. The 1938 Act created the independent regulatory agency, the Civil Aeronautics Board (CAB), with authority to regulate market entry, fares, subsidies, mergers and safety. In 1958 Congress passed the Federal Aviation Act of 1958. This act left the economic regulation of the airlines intact, and transferred safety regulation to the Federal Aviation Administration (FAA) (Bailey, Graham and Kaplan, 1985: 11).

The Regulation

The Civil Aeronautics Board's economic regulation of the industry was imposed, in the main, through its authority to regulate entry and exit and its authority to regulate fares.

The Board during the period from its formation until the deregulation act of 1978 did not award a single major route to a new industry entrant (Bailey, Graham and Kaplan, 1985: 13).

The only way to exit from the industry was through merger with an existing airline. Merger with a struggling line was a way for a healthy airline to expand into new markets (Bailey, Graham and Kaplan, 1985: 13).

In addition to controlling the entry of new airlines into the industry, the Board controlled entry and exit from specific markets by existing airlines. The Board limited service to markets to limit competition.

The Board also, in many cases, prohibited nonstop service by local service airlines. In the sixties and later, it sometimes relaxed these prohibitions where the competition with the trunk was deemed not to be excessive. This was done to improve the financial position of the local service airlines and hence to control subsidy costs (Bailey, Graham and Kaplan, 1985: 13).

The Board also regulated exit from markets and required airlines to provide adequate service to cities on their certificates.

The Board regulated air fares with respect to average cost of the airlines. An airline with high costs would drive up the average cost for the industry, and hence the fares. In this way the high-cost airline would be able to recapture some of the additional cost. This was most important for large airlines. The incentive was especially small to control labor costs. A new union contract would likely establish an industry standard that set costs for all airlines and resulted in increased fares to cover the cost. A strike, however, would mean losses that could not be recovered and might even entail a long-term loss of market share.

The Board's route entry policy had the effect of protecting the airlines from efficient, new entries into a market (Bailey, Graham and Kaplan, 1985: 96). In addition, the CAB used its route authority to aid those airlines which were fiscally the weakest. The Board often awarded lucrative new routes to those lines most in need of financial help (Bailey, Graham and Kaplan, 1985: 13).

Competition

The Board did not regulate airline schedules. Nor did it regulate the type or size of aircraft used. This meant that the main way to compete was through service. Airlines were free to decide when and how to serve a city pair. An airline could serve a route with a nonstop, connecting or through flight. The type of aircraft used proved to be an important way to differentiate product. As the technology improved, airlines improved their equipment, first with pressurized cabins, then with jet service and later with wide-body service.

Domestic Passenger Fare Investigation

In January of 1970, the CAB began the Domestic Passenger Fare Investigation. During the course of the investigation, the CAB found that higher fares encouraged higher capacity on a route. The higher capacity resulted in lower load factors and increased costs (Load factor, as used here, is the ratio of paying passengers to seats available. It is generally expressed as a percent.) At the same time, lower fares caused lower capacity and higher load factors. The Board's response was to establish standard seating densities and to encourage the airlines to reduce capacity on routes with excess capacity.

In addition, the CAB found a number of discount fares to be discriminatory and required them to be eliminated. In this climate of increasingly pervasive regulation and concern over inflation the time seemed right to consider regulatory reform (Oster et al., 1981: 41).

The differential pricing that the Board found discriminatory, Frank calls efficient (Frank, 1983: 238). The airlines enjoy important economies of scale. The marginal cost of adding another passenger to a partially loaded aircraft is much below the average cost per passenger. To price at the average price denies the price-sensitive passenger the flight and the airline the revenue. If the airline can differentiate between the price-sensitive and non-price-sensitive passengers and charge accordingly, they increase market efficiency (Frank, 1983: 238).

The Move to Deregulation

By 1975, President Ford's administration proposed legislation to remove rate control from the CAB. At the same time Senator Kennedy's Senate Judiciary Subcommittee on the CAB was gaining a great deal of publicity claiming that CAB regulation of the airline industry had resulted in much higher fares than would otherwise be the case.

In March of 1975, Board Chairman Robert Timm, a proponent of regulation and capacity limitations, was replaced by John Robson. The Board soon began to liberalize the rules governing charter flights and ended the route moratorium in effect since 1969. Airline officials opposed deregulation, though most believed that a gradual reduction in price controls would not be harmful. The industry seemed to most fear the loss of route-entry regulation.

The industry stance was not united, however. Anti-deregulation forces took another blow in late 1976 when United Airlines stated that it would not oppose deregulation.

Chairman Kahn

In 1977, President Carter appointed Alfred Kahn as chairman of the CAB. Kahn was the first chairman to come out in favor of deregulation prior to his appointment. By the time of his appointment, reform had gained considerable momentum. Outgoing chairman Robson came out in favor of deregulation. Continental and Airwest joined United in favor of deregulation and several diverse political groups also supported regulatory reform or deregulation (Oster et al.,1981: 47).

Under Chairman Kahn air fare restrictions were reduced. By April 1978 approval was not required for up to 50 percent fare reductions. Route authority was also liberalized. By 1978, opponents of a route authorization needed to show cause why a new route authorization should not be granted. The fact that a competitor was already established on the route and objected to the entry of another airline was not sufficient to prevent the authorization as in the past.

In October 1978, President Carter signed the Airline Deregulation Act into law. The act provided for a phaseout of airline regulation over a five-year period beginning in January 1979. The CAB was to be required to approve some new routes each year. It lost all route authority after 1981 and rate authority after January 1983. In fact, deregulation began almost immediately with the CAB granting approval to all requested route and fare changes.

DEREGULATION

The prospect of deregulation was greeted by predictions of bankruptcies, of decreased fares, of increased demand, of increased profitability (for at least the largest lines) and of declining service, especially in the smaller cities. Some observers also predicted a decrease in safety.

Not all of these predictions have been shown to be accurate. While the darkest predictions of widespread bankruptcies proved to be too gloomy, there have been bankruptcies. Under the CAB's regulation there were no bankruptcies. Exit from the industry was by merger only.

Increased competition has caused decreases in air fares. The decreases in air fares resulted in remarkable increases in both traffic and load factors. Additionally, the deregulated airlines were able to structure fares to target price sensitive portions of the market. Since deregulation, an incremental decrease in average fare causes a larger increase in traffic volume (Meyer, 1980: 71). Therefore, the airlines' profitability has increased as well.

In their study "Assessment of Efficiency Effects of Airline Deregulation" Caves, et al. compared U.S. air carriers with non-U.S. airlines that had not been deregulated. They concluded that U.S. airlines improved their relative position in growth of total factor productivity versus the regulated non-U.S. carriers (Caves, Christensen, Tretheway and Windle, 1987: 304).

There were some losers in the deregulation aftermath. Labor lost its ability to command premium wages. The loss was not complete in that increased demand for air travel increased the demand for airline pilots. This did leave a somewhat odd legacy, in that demand for pilots was going up at the same time that wages for pilots were going down.

Under economic regulation airline labor unions were strong and wages were relatively high. The time period since deregulation has been characterized by wage and work rules concessions, new non-union carriers and "B scales." "B scales" were instituted so that newly hired employees are hired under a different, less lucrative wage structure than previously hired employees. This is consistent with the increased level of competition under deregulation.

Since deregulation there has been an increase in the number of mergers and also in the number of new airlines being formed. The previously unregulated intrastate airlines have taken advantage of their new mandate to enter interstate service. In the two years after deregulation Air Florida, Pacific Southwest Airlines, Southwest Airlines and Air California, all former intrastate lines, entered the interstate market.

New commuter lines have also sprung up to offer service in smaller markets, many of which were abandoned by the trunk lines. Many of these commuter lines eventually formed marketing alliances with the major airlines. Most of the larger commuters now belong to such an alliance (Oster and Zorn, 1989: 132).

People Express was an airline that demonstrated the changes brought by deregulation. People Express inaugurated no frills, low cost trans-Atlantic flights and then faded from the scene when other airlines began to compete.

Service Levels

The service to some smaller communities has declined, but the picture is not all bleak. There were more non-hub locales where the total number of flights increased than locales where the number declined, in the period May 1978 to June 1979. (Non-hubs are the smallest airports in the FAA's airport classification system, i.e. those that enplane fewer than 115,000 passengers per year.) However, this increase of flights to non-hubs was small and not evenly distributed. Some non-hub airports lost all of their service while others gained (Meyer, 1980: 27).

The nature of flights into and out of non-hubs changed, also. There were substantial increases in flights from non-hubs to hubs and decreases in flights from non-hubs to other non-hubs. Both Oster and Meyer argue that this change in the nature of the service to small cities has made it more useful to the consumer. They argue that flights to a hub where one will likely find connections to many other places are more useful than flights to another non-hub where air service is also poor. The result is much better service than indicated by the small growth in flights into and out from non-hubs (Oster, 1980: 109) (Meyer, 1980: 76).

Huston and Butler examined service levels before and after the Ozark-TWA and the Northwest-Republic mergers. For their analysis they first compared the number of flights per day to cities served from three major hubs. These hubs were St. Louis in the case of TWA-Ozark, and Detroit and Minneapolis in the case of Northwest-Republic. They also looked at the number of cities served from the major hubs. They found that the number of flights from each served city to the hub decreased. This decrease averaged one flight per day. They also found that a total of 25 more cities were served from these hubs, after the mergers (Huston and Butler, 1988: 205).

However, Huston and Butler also argued that the number of flights into a city is not the proper measure of service level since the advent of hub and spoke routing. They argued that the proper measure was the number of cities that can be reached in a day, by traveling through the hub. The loss of a flight into a hub does not decrease the public welfare as much as additional destinations increases the public welfare (Huston and Butler, 1988: 207).

<u>The Market and Hub and Spoke Systems</u>

Hub and spoke systems allows carriers to fill a higher proportion of their seats. It also allows them to increase the number of nonstop routes between their hubs and other destinations. This has decreased the competition at hub airports (Borenstein, 1992: 49).

Hub and spoke operations do require that passengers change planes more often than traditional routing systems. The increased flights into hubs do, however, allow more flights to be completed without a change of airline (Borenstein, 1992: 49).

Fares at Hubs

Huston and Butler compared fares at St. Louis before and after the TWA-Ozark merger. That merger gave TWA an 82 percent share of the traffic at St. Louis. Huston and Butler refer to hub airports that are dominated by a single carrier like this, fortress hubs (Huston and Butler, 1988: 203). They found an average increase in fares of 21 percent at St. Louis compared to a 3.9 percent change in the average airline fares for the same period (Huston and Butler, 1988: 210).

Borenstein found that the dominant airline at an airport attracts a disproportionate share of the passengers who originate there. He also found that prices at Minneapolis increased faster than the national average after the Northwest-Republic merger as did the prices at St. Louis after the TWA-Ozark merger (Borenstein, 1992: 56).

First Huston and Butler, and later, Borenstein argued that fortress hubs provide the dominant airline a stronger position there that makes competition from other airlines ineffective (Huston and Butler, 1988: 211) (Borenstein, 1992: 54). Certainly most flights by one airline into another's fortress hub are direct flights from its own hubs.

More on Contestability

Bailey and Panzer argued that airline markets were contestable*. They held that there were few barriers to entry into a new market. Capital costs are not sunk costs because they are mobile and can be applied to other markets if conditions change. Further, they argued that a carrier that served both ends of a city pair could readily respond to an opportunity in such a market (Bailey and Panzer, 1981: 128). More recent experience indicates that hub markets are not as contestable as Bailey and Panzer thought.

Morrison and Winston conclude that airline markets are not perfectly contestable, but that they are imperfectly contestable. They regressed the price per seat mile on the number of competitors in a market. They found significant differences in the price per seat mile when there were several competitors as compared to only one or two airlines

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* I use contestable in the broader sense here. I use contestable to describe a market where the threat of competition has some effect on market behavior. Perfectly contestable is used to describe a market where a single potential competitor is sufficient threat to prevent the taking of monopoly rents.

flying the route (Morrison and Winston, 1987: 61). In a perfectly contestable market, where there were no entry costs, additional competitors should make no difference in the price of the service. The presence of potential competitors would be sufficient to keep the prices down.

That a market is not perfectly contestable does not mean that potential competitors don't have an effect. Morrison and Winston also found that potential competitors could substitute for competitors, if imperfectly. They found that it took approximately three potential competitors to have the effect of one actual competitor. They defined potential competitors as airlines that served at least one end of a city pair market. Because potential competitors did increase travelers' welfare, albeit not as much as actual competitors, they concluded that airline markets were imperfectly contestable (Morrison and Winston, 1987: 59).

Summary of History Section

The nature of the economic pressures on the airlines changed with deregulation. These changes in economic pressures caused changes in the way the airline industry operates. Some of these changes were not universally expected. Others, like the hub and spoke routing system were not mentioned in the economic literature at all prior to deregulation.

The question remains: "How have these changes in economics and the changes in operating procedures affected airline safety?"

SAFETY

Concern for airline safety was a major cause of airline regulation in 1938. After the war years, the fifties and sixties were characterized by expansion of the air travel industry and by increased levels of safety. Very little was published about airline safety in the economic literature during this period.

Airline safety has become a hot topic since airline deregulation. When it became clear that airline regulation would change, there were a number of monographs published expressing concern over the likely state of airline safety under deregulation. As the data on airline safety under deregulation became available, several empirical studies were published.

Airline Safety under Regulation

During the regulation era, there were ways to compare the effects of regulation on airline safety. One could compare the safety record of the major airlines with the intrastate carriers. One could also compare the majors with the commuter airlines.

In his book Airline Regulation in America; Effects and Imperfections, Jordan compares passenger fatality rates of the California intrastate carriers and the rates of the larger trunk and local service airlines, over the same routes (Jordan, 1970: 50). The low-cost intrastate carriers were not subject to economic regulation by the Civil Aeronautics Board. They were subject, only, to the much less restrictive California State regulations. All carriers operated under essentially the identical safety regulations of the FAA (CAA prior to 1958).

During the period 1949 to 1965 the accident rate for the California intrastate carriers was 2.67 per 100 million Revenue Passenger Miles (RPM) compared to 0.45 and 0.92 per 100 million RPM for the trunk and local service carriers respectively (Jordan, 1970: 49). (Revenue passenger miles are the number of paying passengers times the number of miles flown and are related to seat miles by load factor.) Jordan points out a difficulty interpreting these figures. The intrastate carrier accident rate reflects only two fatal accidents by the California intrastate carriers during this period. He further notes that one of these accidents was an accident by Paradise Airlines, an airline that accounted for 93 percent of the California intrastate carriers' fatalities while accounting for less than one half of one percent of all RPM carried by California intrastate carriers. If this airline is left out of the statistics, the fatalities per

100 million RPM of the remaining carriers is 0.19, which is lower than either the trunk or local service carriers. If one eliminates the least successful carrier from the group of trunks or local carriers, neither of those fatality rates would be reduced as low as 0.19 (Jordan, 1970: 51). Jordan's analysis emphasizes the difficulty of "measuring" safety by comparing accident or fatality rates, due to the paucity of occurrences.

Comparing accident rates of the certified carriers with the accident rates of the air taxi services or commuter lines might seem like a good way to assess the effects of regulation on air safety. And, indeed, the regulated airlines have a much better safety record. However, the comparison is one of apples to oranges. First, air taxi and commuter services fly much shorter distances increasing the number of takeoffs and landings per revenue mile. As accidents are much more apt to happen in the takeoff and landing phase than while cruising at altitude, this comparison is inherently unfair (Oster and Zorn, 1983: 7).

Additionally, comparisons of accidents per RPM are unfair because the smaller size of the aircraft flown by the commuters biases that calculation. If we look at accidents per operation we find that the accident rate for commuter lines is very near that of the major airlines, but it is still significantly higher (Oster and Zorn, 1983: 7). Even this comparison is not conclusive because of the different types of equipment used by the different operations. The jet powered aircraft used by all the regulated airlines are simply more reliable than the smaller reciprocating engine aircraft used by some commuters. Jet engines themselves are inherently more reliable than reciprocating engines. Also jet powered aircraft because of their higher cruise altitudes and increased rates of climb spend less time exposed to severe weather and mid-air collision potential than their reciprocating engine counterparts.

Also the type of operation itself affects the safety record. Because the commuters by their very nature use smaller, less used airports they do not have the benefits of the best facilities. At these smaller airports the runways are shorter and the ground-based navigation and approach facilities are not as good. Often the weather information is poorer and radar approach control facilities may be poorer or lacking altogether. However, weather and approach minimums are higher for these poorer equipped airports and should compensate for the lack of technical equipment, at least from a safety, if not from a convenience, standpoint.

Oster and Zorn did a study of commuter safety during the seventies. In this study they stated that carrier size was an important determinant in commuter airline safety. In the study they found that commuters above a certain minimum size had a better safety record than smaller lines. The safety record for the larger commuter lines was comparable to the majors when measured in terms of accidents per operation. (Oster and Zorn, 1983: 8).

Non-regulatory Incentives for Safe Operation

Regulatory forces are not the only forces that push for safe operation of an airline. Most airline employees could be expected to have a personal stake in the safe operation of the airline. Pilots have an especially strong incentive as their own safety is directly affected by their actions to maintain a safe operation. Besides the personal incentives of the employees there are also possible market incentives to run a safe airline operation.

Paul Biederman in his book, The U.S. Airline Industry: End of an Era, calls safety a largely discounted but potential source of product differentiation for the airlines. However, while consumers are concerned over airline safety, they generally fail to see differences in safety among the certified carriers. He further states that while the CAB certified carriers have shown a better safety record than the charter operators, the gap is reduced as the supplemental airlines obtain newer equipment (Biederman, 1982: 53).

Andrew Chalk likens the market forces on aircraft manufacturers to classic lemon equilibrium, where the consumer is unable to determine which aircraft are good or bad (Chalk, 1986: 44). While the consumer is unable to enforce airline safety standards through purchase decisions, Chalk demonstrates that at least in the case of the DC-10 crash on May 25, 1979 the capital market did provide a market incentive to invest in safety.

Chalk studied the stock market's response to McDonnell Douglas at the time of the accident, by correlating newspaper accounts of the accident with McDonnell Douglas stock price movements. He found a $200 million decline in McDonnell Douglas shareholder wealth associated with the accident (Chalk, 1986: 44).

Karels criticizes Chalk's study. Since the accident was blamed on faulty maintenance practices by American Airlines, Karels argues that there should have been no effect on McDonnell Douglas stock. Further, he states that by extension of Chalk's argument, American Airlines should have been affected by a loss of shareholder wealth. Karels finds no such loss for American and in fact the losses he finds for McDonnell Douglas are much smaller than those Chalk finds and are not significant (Karels, 1989: 353).

I find Karels' arguments weak. At the time of the accident and for most of the period of Chalk's study, most observers expected McDonnell Douglas to be blamed for the accident. The newspapers explained in great detail all of the difficulties that McDonnell Douglas had with the DC-10. They hardly mentioned the issue of American's maintenance practices. They even implied, in some cases, that McDonnell

Douglas's concern about American's maintenance practices was simple misdirection on their part.

Barnett and Lo Faso performed another study of the aftermath of the 1979 DC-10 crash. They looked for passenger avoidance of the DC-10. They found no evidence of avoidance (Barnett and Lo Faso, 1983: 1225).

After the 1989 crash of a DC-10, Barnett et al. found some resistance to the DC-10. The effect was short-lived and began to fade within one month (Barnett, Menighetti and Prete, 1992: 46).

Borenstein and Zimmerman looked for market incentives for the safe operation of commercial airlines. For their study they used accidents with at least one on-board fatality. They found little or no effect on consumer response prior to deregulation and only weak response after deregulation. They also looked for changes in airline equity associated with accidents. They concluded that overall the changes in equity value were lower than the social costs of the accidents. For their sample they found an average equity loss of $4.5 million associated with an average of over forty fatalities. In addition to the loss of life, most accidents involved the total destruction of the aircraft (Borenstein and Zimmerman, 1988: 933).

The FAA and Other Safety Considerations

Economic and safety regulation of the airlines were separated by the Federal Aviation Act of 1958. The Airline Deregulation Act of 1978 did not change the FAA's role in regulating airline safety.

Some observers like John Godson, who has written a number of books condemning the airlines' safety record, maintain that the industry has a history of under-regulating safety. Godson in his books (Unsafe at any Height, Runway, The Rise and Fall of the DC- 10, etc.) is especially hard on the FAA and claims that the agency has neither the will nor the expertise to regulate airline safety. He is especially incensed at what he considers the FAA's unwillingness to make the tough decisions required to ensure airline passenger safety (Godson, 1973: 135).

Captain "X," the author of the book Unfriendly Skies: Revelations of a Deregulated Airline Pilot, maintains that increased competitive pressure brought on by deregulation has adversely affected safety ("X" and Dodson, 1989: 171).

Safety is determined not only by the economic environment, i.e. competition, regulation, etc., but also by the level of government expenditure on safety enforcement and infrastructure (airports, air traffic control, weather forecasting service, etc.). The optimum level of expenditure on safety enforcement and infrastructure may be different post deregulation compared to during regulation (Moses and Savage, 1989: 315).

To the extent that economic deregulation is the cause of increased airline traffic it should be accompanied by increased expenditures on surveillance and infrastructure. Decreases in safety level that are attributable to a failure to make these expenditures are different than decreases that are attributable to changes in economic regulation (Moses and Savage, 1989: 313). The decreases due to a lack of expenditures on surveillance and infrastructure are not the primary concern of this study.

The volume of air traffic has increased tremendously since the onset of deregulation. While traffic volume has gone up, the number of airports available to the airlines has remained static. The last new airport constructed was the Dallas-Ft. Worth airport in 1973 (Bailey 89). When the new Denver airport is completed it will have been over twenty years since the last new airport was completed. Deregulation occurred in the first decade of this hiatus. Deregulation caused a large increase in traffic that was not compensated for by an increase in infrastructure.

SAFETY IN THE DEREGULATION ERA

Deregulation has caused a number of changes in the airline industry. It is responsible for increased levels of competition, changes in the route structure, and shifts in travel patterns. Deregulation is also at least partly responsible for large increases in air travel in the past decade. It is the cause of changes in the profitability of airlines and is credited with causing a number of airline bankruptcies. Each of these changes has had a potential impact on safety.

Safety and Competition

Safety is expensive. It costs money to train aircrews, to inspect aircraft, and to perform preventative maintenance. There is an optimum amount of safety for the airlines to provide. This optimum amount is something less than absolute safety. If additional safety expenditures will not result in savings from losses to society at least equal to the expenditures, the expenditures should not be made.

According to Moses and Savage, there is every reason to believe that the airlines provided more than the optimal amount of safety under regulation. The airlines competed in the area of service because they could not compete on the basis of price. They therefore provided too much service. For instance, load factors before deregulation were lower than after because they provided too many flights. They probably also provided too much of the service called safety (Moses and Savage, 1989: 309).

Change to Commuters

The commuter and local service airline's safety record improved significantly in the post deregulation era (Oster and Zorn, 1989: 139). Safety regulations for commuter operations were changed in 1978. Other changes in market structure make the commuter airlines, as a group, look more like the safest commuters in the earlier Oster and Zorn analysis (Oster and Zorn, 1983: 6).

The commuter airlines serve many communities that were served by the majors prior to deregulation. The transition from jet service to commuter service could be expected to adversely affect airline safety for these markets.

Deregulation may also have caused an increase in the average number of stops one makes per trip. This increase of operations per trip increases the travelers' exposure. The overall effect on air safety is probably quite small (Rose, 1992: 80).

Shift of Travel from Highways to Air

The commuters have increased the number of flights into the smaller markets as they have taken these markets over (Rose, 1992: 79). Service has changed to a hub and spoke which would make the flights from these smaller markets more attractive. These factors combined to induce a shift from automobile to air travel. To the extent that travelers shift from highway to air travel, the total transportation system's safety is improved.

Accident rates for the air transportation system are quite low. Conversely the accident rates for automobiles are relatively high. Therefore, it would seem that any change from highway to air travel would have a very positive effect. However, there are some statistical caveats that need to be addressed.

Rural interstates are the safest of our highways. They are also the roads that compete most with air travel. Highway travel incurs nearly the same risk per mile on long or short trips. Air travel incurs almost all of its risk on the takeoff and landing phases of flight. Consequently, the risk per mile is much higher for short trips (Evans, Frick and Schwing, 1990: 239).

The accident rates for highway travel vary considerably for different profile drivers. This difference in profile does not bear on air travel accident rates. Further, the average air passenger's profile is different from that of the average driver. A belted, low risk driver, driving on a rural interstate on a short inter-city trip, during daylight hours, enjoys approximately the same low risk of fatality as an air passenger making the same inter-city connection (Evans, Frick and Schwing, 1990: 239). Still the shift from highway to air travel has had a positive effect. Rose calculates the figure at 90 to 140 lives per year (Rose, 1992: 82).

New Carriers

Deregulation spawned a number of new air carriers. According to Barnett and Higgins the safety record of these new entrants is not enviable. As a group they averaged twelve times as many fatalities per flight as the established majors during the period 1979-1986 (Barnett and Higgins, 1989: 1).

The risk is sensitive to the measure of safety performance, however. Using accidents per departure, the new entrants appear to perform at least as well as the established carriers (Rose, 1992: 86).

Age of Aircraft

Competition levels have increased since deregulation. Traffic levels have also increased. This has caused airlines to postpone retiring aging aircraft from the fleet. Fleet age has been widely viewed with concern. The Aloha Airlines accident in April 1988 highlighted this concern.

Morrison and Winston looked at aircraft age and accidents. They compared the age (in flying hours) of aircraft involved in accidents pre and post deregulation. They found that the age of aircraft involved in accidents had increased during deregulation but not as fast as the average age of the fleet (Morrison and Winston, 1988: 12).

Profitability and Safety

Increased competition, leading to reduced profitability, leading to shortcuts in training or maintenance is touted as a mechanism by which deregulation could lead to reduced safety. Some observers suggest that if deregulation increased profitability, as seems likely, that deregulation may then have improved safety (Rose, 1989: 93).

In a study of airline safety during the regulation era, Golbe found no relationship between safety and profitability (Golbe, 1986: 317). In a more recent study, Rose looked for a relationship between profitability and safety. She found that higher operating profits are associated with lower accident rates the following year (Rose, 1989: 97).

Deregulations Effect on Safety

There have been a number of recent studies that addressed the question, "How has deregulation affected airline safety?" The answers have varied from researcher to researcher.

Morrison and Winston looked for a deregulation effect on insurance expenses for the airlines. They found no correlation between deregulation and safety (Morrison and Winston, 1988: 10).

Barnett and Higgins looked at fatalities per departure to measure airline safety. Fatality rates have decreased dramatically for the U.S. domestic trunks since deregulation. They conclude that the established carriers were not affected by deregulation. However, the new jet entrants that arose since deregulation did not enjoy the same low fatality rates. Had deregulation not occurred, these new entrants would not have existed. Therefore, the airlines' safety record would have improved even more if deregulation had not occurred (Barnett and Higgins, 1989: 17).

Rose looked for and found no deregulation effect on safety (Rose, 1992: 89). Morrison and Winston looked to see if pilot experience was a factor since deregulation. They found that the average age and flying experience of pilots involved in accidents is higher since deregulation. They conclude that deregulation has not caused the airlines to hire less experienced pilots (Morrison and Winston, 1988: 11).

Summary of Safety Section

Many researchers have addressed the question "How has deregulation affected airline safety?" The answer is muddled by continued changes in the industry. It is, however, safe to draw some conclusions from the work already done.

First, the safety record of the airlines has continued to improve during the deregulation era. Profitability appears to be positively linked with safety in the case of the smaller airlines. The change in travel patterns from highway travel to air travel has a positive effect on overall transportation safety. Older, well established airlines, as a group, are safer than the new entrants, as a group.

There remains the question of the safety performance of those airlines most directly affected by the deregulation act. The large trunk lines that carry the bulk of the country's air passengers have an improving safety record during the deregulation era, but is it as good as it would have been under regulation?

CHAPTER III

THE MODELS AND METHODOLOGY

MEASURING SAFETY

Government Statistics and Definitions

To determine if deregulation affected airline safety, one must first decide how to measure safety. Even defining something so seemingly simple as a "fatal accident" can be surprisingly complex. The FAA reports a number of different statistics indicative of safety levels. These included accidents, fatal accidents, various accident rates, and service difficulty reports.

Accidents. Accidents are the most commonly used indicator of safety. The National Transportation Safety Board defines an aircraft accident as follows:

> An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with intention of flight until such time as all such persons have disembarked, and in which any person suffers death or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached thereto, or in which the aircraft receives substantial damage.

and fatal injury as:

> Any injury which results in death within 30 days of the accident. (NTSB, various)

The NTSB reports accidents and fatal accidents for air carriers. From the definitions given above it is easy to see that accidents caused by hijackings or sabotage should be included, and when the NTSB reports fatal accidents it reports those resulting from these causes. Yet when it reports fatal accident rates it often leaves out fatalities that result from hijackings (NTSB, various).

The NTSB similarly reports as fatal, those accidents where a collision between a general aviation aircraft and an airliner results in the death of a general aviation passenger. Again when calculating rates, these accidents are not included.

Other Measures. The FAA is not just interested in accidents. Some events that are indicative of safety levels are not serious enough to be categorized as accidents. These events are called incidents. The FAA also records and reports these incidents. According to the Department of Transportation an incident is:

> An occurrence involving the operation of one or more aircraft in which a hazard or potential hazard to safety is involved but which is not classified as an accident due to degree of injury and/or extent of damage. (U.S. DOT, 1986: 6)

Another category of events that the FAA tracks are called Service Difficulty Reports or SDR's. SDR's are reported for a variety of problems including in-flight fires, false fire warnings and certain in-flight engine shutdowns. Unfortunately, the criteria for reporting SDR's is vague enough to render them inappropriate for this type of analysis.*

The Part 121** airlines report accidents and incidents per the U.S. Department of Transportation's Order 8020.11, Aircraft Accident and Incident Notification, Investigation and Reporting. The NTSB investigates all airline accidents and selected incidents involving Part 121 carriers.

Safety as Measured in the Literature

Some researchers use fatal accidents as the appropriate measure of airline safety. Some go further and differentiate between those accidents that are fatal to only a small percentage of the passengers and those airline disasters that kill nearly everyone on board (Barnett and Higgins, 1989: 5).

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* The worst of the criteria is the last which reads:

> Any other failure, malfunction or defect in an aircraft that occurs or is detected at any time if, in the airline's opinion, that failure, malfunction or defect has endangered or may endanger the safe operation of an aircraft used by it.

In addition to the vague definitions the numbers are staggering and they make analysis a daunting task. For instance, in the two-year period January 1987 to January 1989, over 24,000 SDR's were filed with the FAA by the U.S. air carriers (Seattle Times, 1989: E1).

** The scheduled airlines, the subject of this study, are those airlines operating under Part 121 of the Federal Aviation Regulations (FARs). Those eight major airlines that operated for the full period of the study were selected. They were American, Continental, Delta, Eastern, NorthWest, PanAm, TWA, and United.

Chance and Ferris looked for stock market changes caused by airline disasters. For their analysis they used only accidents that resulted in more than ten fatalities (Chance and Ferris, 1987: 154).

While these disasters make headlines and are the sort of thing most of us associate with the term airline accident they are not suited to measuring the effect of deregulation on airline safety. These kinds of disasters are simply too rare*.

Oster and Zorn, also argue that accidents are rare enough events that further limiting one's analysis should be avoided (Oster and Zorn, 1989: 135).

Rose argues that FAA inspection results and fines are inappropriate measures of safety. These are more measures of safety inputs than outputs. She argues that how these inputs might translate to safety outputs is not well understood (Rose, 1989: 95).

Rose further argues that incidents are not appropriate measures to use because the definition of an incident is not as objective as that of an accident. She also argues that incidents are more likely to include a higher proportion of events attributable to air traffic control errors (Rose, 1989: 96).

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* Thin statistics do not result in biased estimates of regression coefficients, but rather inefficient estimates (Rose, 1989: 97).

Divisor

To change the raw numbers of accidents or incidents to a rate, one must divide by a suitable factor representing exposure. There are several measures of accident rates in use for the airlines. These include accidents per revenue passenger mile (RPM), fatalities per RPM, and accidents per flying hour.

Revenue Passenger Miles. Revenue passenger miles is the most common measure of air transportation use. Fatalities per RPM is probably the best available measure of the public's risk. It is not necessarily the best measure of the airlines' efforts to maintain a safe operation.

The airline accident rate measured in accidents per RPM is biased downward as equipment gets larger. The accident rate as measured in fatalities per RPM is biased upward as load factors increase. These biases are due to changes in Revenue Passenger Miles that don't have a direct bearing on the airlines safety practices.

Operations. Oster and Zorn make a strong argument for using accidents per operation (one takeoff and landing) as a measure of safety when comparing one airline to another. This is especially important when comparing short haul lines to trunks. The takeoff and landing phases of flight are the most dangerous portions of any flight. Short haul and commuter airlines make many more takeoffs and landings per million revenue passenger miles than do trunk airlines (Oster and Zorn, 1983: 7).

Hours. For the purposes of this study accidents and incidents per 100,000 flying hours will be used. In this study, each airline's safety record will be compared only to itself. Also the airlines used in the study have been chosen so that the nature of their operations has not changed a great deal over the time frame in question. Therefore, the advantage of accidents per operation over accidents per flying hour does not accrue in this case*.

Rates Used in this Study

The Airlines. The airlines I selected for this study are American, Continental, Delta, Eastern, NorthWest, Pan American, Trans World and United. Of the eleven trunk** airlines that entered the deregulation era in 1979 these eight airlines are the only ones that remained in business

* The most obvious way the nature of operations could change and affect exposure as measured by hours of flying time would be to change the average stage length or the length of the flights. To confirm the hypothesis of no advantage using operations, I compared regressions for three OLS models. The results are shown in the appendix. I compared the results from the model using hours as the measure of exposure with two other models. The first uses operations as the measure and the second uses operations and stage length as measures of exposure. These are the measures used by Oster and Zorn, and by Rose, respectively. The results are similar to the results obtained by the OLS model using hours as the measure of exposure.

** Trunk was the term used to designate the large long haul airlines operating under Part 121 of the FARs. The locals were the smaller, short haul carriers that also operated under Part 121.

for the duration of the study. The other trunks were Western, National, and Braniff. Their dispositions were: Western was purchased by Delta, National was purchased by Pan Am and, Braniff entered bankruptcy. Since the end of the study period Eastern and Pan American have also ceased to operate.

Commuters and Intrastate carriers did not come under the same CAB regulations as the trunk and local airlines. The local and regional airlines have for the most part undergone a great deal of change during the time since deregulation. These changes include mergers and changes in route structure that make comparisons very difficult. Those regionals that have undergone the least change tend to be rather small so that there are few data points to work with, making analysis difficult.

Exclusions. Oster and Zorn omit intra-Alaska, intra-Hawaii, international, Caribbean and charter operations from their analysis (Oster and Zorn, 1989: 136). Other researchers have excluded international and/or charter operations from their analysis (Barnett and Higgins, 1989: 5) (Rose, 1989: 97). I have included all operations for each of the selected airlines. The purpose of this research was to determine how deregulation affected the individual airline's operations. There is no reason to believe that deregulations effects will be different on different segments of a major airlines operations.

In this analysis, I have used incident and accident statistics as a measure of safety levels rather than accident statistics alone. The advantage to using incident statistics is that accidents are rare resulting in small sample problems, while incidents are common enough to be useful in most statistical analyses. One of the disadvantages of using incident statistics is the possibility suggested by Rose that incidents data might contain more occurrences caused by agents other than airlines or airline employees. She is concerned specifically by the possibility that incidents are more often caused by air traffic control. This and other issues relating to the use of incidents as a measure of safety will be addressed later.

TIME SERIES MODELS

Deregulation Timing

Having determined how to measure safety, the next step is to determine exactly when deregulation took place. Again this is more complex than one might hope.

The airline deregulation act was signed into law in October 1978. The act called for the CAB to begin granting new routes by January 1980. In fact the CAB began granting new routes immediately. This was a drastic change from the policies of the early 1970's.

After the Domestic Passenger Fare Investigation of 1970, the Board reduced the capacity of the airlines to compete. It established standard seating densities to discourage excess capacity on highly competitive routes. It also ruled certain discount fares were discriminatory.

By the mid 1970's the political climate was such that this kind of strict economic regulation was much out of favor. By 1978, prior to the deregulation act, the restrictions on fare reductions were largely eliminated. Route authorizations had also been liberalized somewhat, by 1978.

Deregulation Timing in the Literature

The literature contains a number of empirical studies where the regulation era was compared and contrasted with the post-regulation period. A sampling of these studies demonstrates the difficulties one encounters in establishing a date for the end of regulation.

Oster and Zorn use 1978 as the date of deregulation. For their analysis they compared the period 1970-78 with the post-deregulation period of 1979-85 (Oster and Zorn, 1989: 139). Moore also uses 1979 as the first year of the deregulation era (Moore, 1989: 13).

Morrison and Winston claim that certain economic effects of deregulation stabilized, after a transition period ending in 1982 (Morrison and Winston, 1990: 390).

Bailey and Panzar comment that the Civil Aeronautics Board's policies on entry changed in early 1978. Yet, they maintain that entry barriers did not really topple until after the Airline Deregulation Act passed in October of that year. They point to January 1979 as the date when the new policies were in full effect (Bailey and Panzar, 1981: 130).

Morrison and Winston use 1976 as the first year of the deregulation era in their analysis of air safety and deregulation. They provide no explanation for their use of such an early date (Morrison and Winston, 1988: 11).

The literature provides one other helpful note. Rose looked for and found a relationship between the economic well-being* of an airline and its safety record the following year (Rose, 1992: 111). It is not likely that economic deregulation's effects would show up more quickly than the effects of economic well-being.

Bailey's contention that deregulation was in full effect in January 1979 and Rose's findings of a one-year lag from economic changes in well-being to changes in safety performance are the criteria I considered most important in making my decision on the timing for the dummy variable (Bailey and Panzar, 1981: 130) (Rose, 1992: 111). I am using 1980 as the year of my dummy variable for

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* Rose used operating margin as her measure of economic well-being. She defines operating margin as one minus the operating expense divided by the operating revenue (Rose, 1992: 100).

deregulation. I did not end my analysis of the timing issue here. Morrison and Winston's point that certain effects stabilized after 1982 is important too (Morrison and Winston, 1990: 390). That the effects of deregulation might take a number of years to come to fruition is entirely credible. I will address this issue later in this section.

Time Series Model

Since the beginning of the Jet Age, airline accident rates have continued a downward trend. This is true for the period since deregulation too. The Null Hypothesis for the study will be that "Economic deregulation of the airlines has had no effect on airline safety." To test this hypothesis I have run a time series regression analysis of accident and incident rates using a dummy variable for pre and post deregulation. Since accidents per hour has trended lower approaching zero asymptotically, a regression equation using the log form is suggested.

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} \tag{1}$$

To Test for a deregulation effect I add a dummy variable for deregulation. The equation can then take two forms.

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} + \beta_2\ \text{Dummy} \tag{2}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} + \beta_3\ \text{Dummy} * \text{Time} \tag{3}$$

The form in equation (2) assumes that the effects of deregulation change the intercept term. This might be the case if deregulation induced airlines to make a one-time change in inspection cycles. If lengthening an inspection cycle caused a incremental decrease in safety, we would then expect that β_2, the regression coefficient for the dummy variable, would be positive and significant.

Equation (3) assumes that the effects of deregulation change the rate at which safety improves over time. This might be the result if deregulation induced the airlines to reduce spending on training. Assume that a certain portion of the training dollars an airline spends are effective in improving safety performance. This seems reasonable given that a great deal of the training effort is focused on analyzing past accidents and how to avoid repeating them. Then if spending on such training was reduced we could expect that the rate at which safety performance improved would be reduced.

It is possible that both of the foregoing effects will be found hence equation (4)*.

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} + \beta_3 \text{ Dummy} * \text{Time} \qquad (4)$$

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* Note that for periods before deregulation the dummy is equal to zero and equation (4) reduces to equation (1). For periods after regulation, where the dummy is equal to one, equation (4) can be rearranged to:

$$\ln(\text{Rate}) = (\beta_0 + \beta_2) + (\beta_1 + \beta_3) * \text{Time}$$

Box-Cox Transformation

The log form for measuring safety performance is not the only form the equation could take. An inverse time function would also approach a zero accident rate asymptotically. In cases where the exact form is not known the use of a Box-Cox transformation is appropriate. G. E. P. Box and D. R. Cox suggest a transformation of the form:

$$(Y^{\lambda} - 1)/\lambda \tag{5}$$

where: $0 < \lambda < 1$. Note that here $\lim \lambda \rightarrow 0\ [(Y^{\lambda} - 1)/\lambda] = \ln Y$ For this formulation λ is estimated along with the other regression coefficients (Box and Cox, 1964: 214). Then:

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_2\ \text{Dummy} \tag{6}$$

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_3\ \text{Dummy} * \text{Transformed Time} \tag{7}$$

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_2\ \text{Dummy} + \beta_3\ \text{Dummy} * \text{Transformed Time} \tag{8}$$

Instability in the Time Series Model

In the previous models I have looked for instability in the time series model caused by deregulation. Specifically, I used a dummy variable that is zero before 1980 and one beginning in 1980, to test for instability in the time coefficient at that point. As I mentioned earlier the first quarter of 1980 is not the only point that could be chosen to represent the beginning of deregulation. Nor is deregulation the only shock that could cause instability in the coefficient.

There are several techniques that can be used to test for instability of the slope coefficient. Quandt's log likelihood Ratio Technique tests to determine for an abrupt change in the regression relationship at some unknown time. Comparison of the recursive residuals and their standardized sum or sum of squares to approximate confidence bounds, called CUSUM or CUSUM of squares tests, can be used to test for instability and its location. Another method to investigate time variation is to calculate the regression over a short segment of successive observations and move the segment along the series. Comparisons of the coefficients so calculated are then used to test for instability and its location (Brown, Durbin and Evans, 1975: 151).

I have used the CUSUM and CUSUM of squares tests to seek instabilities in the time series model.

Other Model Considerations

The airline fleet age has gone up since the advent of deregulation. This has caused some observers to question the effect this might have on airline safety. An increasing fleet age can affect safety in two ways. First, it is possible that airliners could simply wear out. This would not apply to components like engines or avionics that are replaced several times during the lifetime of an aircraft, but would apply to the airframe itself. While accidents of this sort are extremely rare, they do happen. The most spectacular recent example is the Aloha accident in 1988. In that accident the airframe failed and a portion of it separated. One life was lost.

There is another way that an increase in fleet age could affect safety performance. An increase in fleet age is an indication that the airlines are not replacing older aircraft with newer presumedly safer models as quickly as in the past.

Morrison and Winston looked at aircraft age and accidents. They compared the age (in flying hours) of aircraft involved in accidents pre and post deregulation. They found that the age of aircraft involved in accidents had increased during deregulation but not as fast as the average age of the fleet (Morrison and Winston, 1988: 12). Given these results and the difficulty obtaining detailed fleet age data I have not pursued this issue further.

CONTROLLABLE OCCURRENCES

Certain types of incidents are more apt to be under an airline's control than are others. Incidents that are aircraft maintenance related and those related to aircrew training are examples of incidents over which airlines have control.

It was the airlines who were deregulated by the Airline Deregulation Act of 1978, not the National Weather Service, the FAA, or the aircraft manufacturers. It is appropriate then, to use those accidents and incidents that are under the control of the airlines in determining if deregulation had an effect on airline safety.

Using only those accidents and incidents that are under the control of the airlines will have an additional benefit. Rose claims accidents are most often attributable to factors under the airlines' control. Such things as pilot or crew error, maintenance, or lack of training are the usual causes. Conversely incidents are likely to have a higher proportion of events attributable to air traffic control errors. Therefore, incident rates might be more sensitive to the air traffic controllers strike of 1981 than accident statistics (Rose, 1989: 96). By focusing on accidents and incidents under the airlines' control we can eliminate any problems caused by this supposed bias in incident statistics.

Having decided to use only those occurrences that are under the airlines' control, it remains to make the appropriate separation. But first let us see how others have addressed the problem.

Cause and Other Researchers

Other researchers have separated accidents into those under the airlines' control and those not under their control. It is instructive to look at these earlier efforts.

Oster and Zorn compared pre and post deregulation accident rates for the major airlines and the commuters. For their analysis they assigned accidents to one of eight categories according to "primary contributing factor" (Oster and Zorn, 1989: 142). Their assignments differ significantly from the type of assignments I have made.

Oster and Zorn minimize the number of occurrences assigned to the pilot error category. They assign weather as the "primary contributing factor" in some cases where the pilot flew into known inclement weather. They call the distinction between pilot error and weather their most subjective (Oster and Zorn, 1989: 143).

They also list general aviation as the "primary contributing factor" for any accident where a general aviation aircraft was involved! This is true even for accidents like the PSA crash in San Diego (Oster and Zorn, 1989: 144). In this accident the PSA 727 ran a general aviation aircraft down from behind. The general aviation aircraft was where it was told to be by Air Traffic Control (ATC). ATC pointed the aircraft out to the PSA crew and instructed them to remain clear of it.

Oster and Zorn found that commuter carrier accidents caused by weather (their cause listing) happened at half the former rate after deregulation. As the weather certainly wasn't that much better we can only assume that the real cause of these accidents was pilot error. Pilot error accident rates also improved over this period according to their figures (Oster and Zorn, 1989: 145).

Mitchell and Maloney looked for a brand name effect for airline accidents that were under an airline's control. For their analysis, they used pilot error as the criterion to determine that the airline was at fault. They did not use accidents caused by other factors like maintenance. They grouped maintenance-related accidents with those like air traffic control mistakes that are outside the airlines' control (Mitchell and Maloney, 1989: 334).

Criteria Used in this Analysis

For my analysis I have used the accidents and incidents that the National Transportation Safety Board investigated. To accommodate data availability, I have limited the analysis to the period 1964 through 1988. I obtained from the NTSB computer listings of all the Part 121 accidents and incidents for that period. These listings include cause codes and narrative descriptions of the occurrences.

Dividing accidents and incidents into those under the direct control of the airline and those not under their direct control requires using some subjective standards. It is easy to assign most maintenance-related incidents to the group under the airlines' control. Maintenance-related incidents list a system failure or malfunction code from the Air Transport Association Aircraft Component Code Table as the primary cause. Most also list a secondary cause.

It is also easy to assign incidents caused by air traffic control errors and those caused by unruly passengers to groups beyond the airlines' control. But others are not so easy to assign.

The primary cause listed for an incident where a flight attendant was injured when the aircraft encountered clear air turbulence (CAT) is "continued flight into area of severe turbulence." The implication is that the aircrew was responsible. The trouble with this is that if the CAT was not forecast, and if the crew was not warned by a previous flight that the turbulence was there, they would have no way of knowing it.

Some occurrences have both a primary and a secondary cause and one is under the airline's control and the other is not. In general, the primary cause will be used as the determining factor. Therefore, the incident with "continued flight into area of severe turbulence" listed as the primary cause is under airline control even though the turbulence is not.

An exception is the case where aircrew error is listed as the primary cause and improper or conflicting instructions from air traffic control (ATC) is listed as the secondary cause. An example of this is incidents when two aircraft respond to the same clearance and ATC doesn't catch the discrepancy (There is no way for the aircrew to know that this has happened, since they can't receive and transmit at the same time.)

Another example is an incident where an aircrew aborted a takeoff on ATC instructions issued late in the takeoff roll. The late abort caused two blown tires. The primary cause is listed as aircrew error i.e. aborted the takeoff late, resulting in two blown tires. The secondary cause is ATC issued improper instructions i.e. called for an aborted takeoff late in the takeoff roll. (The Traffic Sector had become overloaded.) It is clear that safety is not enhanced by encouraging the crew to avoid blown tires by continuing the takeoff roll in the face of ATC instructions to the contrary.

It should be noted, that by not listing these incidents as under the airlines' control, the implication is not that they are the fault of the air traffic controllers. Rather it is simply that the airline cannot control these incidents by providing the aircrew with more or better training.

A small number of occurrences could not be classified. These included accidents that occurred under the jurisdiction of a foreign power where the NTSB did not have the results of the accident investigation. They also included a very small number of accidents, where the investigation was closed with the cause listed as undetermined.*

After separating the occurrences into those under the control of the airlines and those not under their control, I was able to recalculate rates using only those occurrences under the control of the airlines. I then ran the regressions suggested by the models in equations (2), (3), (4), (6), (7), and (8).

ECONOMIC HEALTH AND SAFETY

One way in which deregulation might affect safety performance is through changes in economic well-being. If the additional competitive pressure caused by deregulation squeezed an airline's profit margin, the airline might scrimp on safety inputs to recover some of the lost profit. This raises the question of a possible relationship between economic well-being and safety performance. Other researchers have looked for such a relationship.

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* Of the 1,118 occurrences investigated, a total of fifty-six had causes that could not be determined. These fifty-six occurrences were left out of the analysis.

Economic Health and Safety in the Literature

Golbe looked for and found no relationship between economic well-being and safety. She regressed the square root of accidents on average current profits, departures and stage length. Using aggregate data she found no significant relationship between profits and safety (Golbe, 1986:100).

Rose confirms Golbe's results using non-lagged aggregate data. However, she goes on to show that using pooled data masks the true relationship. Using cross-sectional data and regressing accident rates on lagged operating margin she found a correlation between profit and safety. Specifically she found a significant correlation between higher operating margins and lower accident rates in the following year (Rose, 1989: 111).

In view of these findings it is important to control for profitability in the earlier models.

Measures of Economic Well-being

The usual measure of economic well-being is Return on Investment (ROI). However ROI is affected by historical costs and accounting methods. A statistic that reflects current operating health might be more useful.

Other researchers also found ROI less than satisfactory. Golbe used both ROI and net income. She cited the link between capital expenditures and safety improvements as her difficulty with ROI (Golbe, 1986: 312).

Gomez-Ibanez, Oster and Pickrell use operating ratio as the appropriate measure. They looked for the effects of deregulation on profitability. For the operating ratio they used operating expenses divided by operating revenues (Gomez-Ibanez, Oster and Pickrell, 1983: 81).

Rose uses operating margin as a measure of economic well-being. She defines operating margin as one minus the operating ratio (Rose, 1989: 100).

I have selected operating ratio as the measure of profitability to use for this analysis. Such a statistic can be calculated from data available from Data Base Products, Inc. Data Base Products extracts the data from Form 41 Data reported by the airlines to the FAA and CAB.

Model

To control for profitability I have used the following models.

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} + \beta_2\ \text{Dummy} + \beta_4\ \text{Opratio} \tag{9}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} + \beta_3\ \text{Dummy} * \text{Time} + \beta_4\ \text{Opratio} \tag{10}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1\ \text{Time} + \beta_2\ \text{Dummy} + \beta_3\ \text{Dummy} * \text{Time} + \beta_4\ \text{Opratio} \tag{11}$$

These are simple modifications of the models shown in equations (2) and (3)*. Here Opratio is used to indicate the operating ratio lagged one year. There is an advantage to these new formulations. With these models, if the

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* Note here the use of time as the measure of technological progress. As noted earlier time turns out to be a better measure than uncontrollable occurrences.

regression coefficient for the dummy term is significant, we can be assured that it is not due to changes in profitability following deregulation.

CHAPTER IV

ANALYSIS

REGRESSION RESULTS

Data

The data for this study is taken from published National Transportation Safety Board (NTSB) statistics and from computer tape data supplied by the NTSB. The published data includes listings of fatal accidents and total accidents and flying hours. The tape data included listings of incidents and accidents that the NTSB has investigated. The listings are for Part 121 carriers, and occurrences from 1964 through 1988.

Table I shows fatal accidents and total accidents for the years 1961 through 1987. Table II shows the tabulated results of sorting the accidents and incidents into those under the airlines' control and those not under their control. (The appendix has a more complete listing and includes the results from each individual occurrence.)

The column also lists, under the heading "other occurrences," the number of occurrences that could not be assigned to one category or other. This was most often due to the incident or accident occurring outside U.S. jurisdiction. More rarely, it was because the investigation was closed without a cause being determined. Fifty-six (approximately 5%) of the occurrences were classified as "other."

TABLE I

FATAL ACCIDENTS AND TOTAL ACCIDENTS

Year	Fatal Accidents	All Accidents	Flying Hours
1961	6	66	3654503
1962	6	47	3491174
1963	6	54	3604228
1964	11	59	3774771
1965	8	65	4071987
1966	5	56	4232982
1967	8	54	4924080
1968	13	56	5521931
1969	8	51	5892254
1970	4	43	5780503
1971	7	43	5706270
1972	7	46	5659485
1973	8	36	5898575
1974	7	43	5474495
1975	2	30	5422665
1976	2	22	5587601
1977	3	20	5800843
1978	4	20	6031743
1979	5	23	6700322
1980	0	15	6797578
1981	4	25	6571288
1982	3	15	6440163
1983	4	22	6649009
1984	1	12	7438497
1985	4	17	7947435
1986	1	20	9356906
1987	4	30	9711000

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES

American Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	8	7	1	0	363,437
1965	10	8	2	0	391,523
1966	11	7	3	1	453,253
1967	5	3	2	0	541,077
1968	7	6	1	0	618,650
1969	1	1	0	0	637,328
1970	10	6	4	0	671,977
1971	12	10	2	0	658,728
1972	7	4	3	0	642,511
1973	10	7	3	0	661,120
1974	7	6	1	0	614,117
1975	9	6	3	0	629,924
1976	6	3	3	0	656,110
1977	5	4	1	0	671,540
1978	5	4	1	0	688,255
1979	5	4	0	1	747,748
1980	1	0	0	1	693,604
1981	3	3	0	0	610,468
1982	3	3	0	0	619,230
1983	8	6	0	2	658,990
1984	5	5	0	0	749,857
1985	12	9	3	0	858,870
1986	6	4	2	0	946,058
1987	14	6	8	0	1,168,616
1988	15	9	6	0	1,337,015
total	185	131	49	5	17,290,006

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Continental Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	0	0	0	0	77,582
1965	4	2	2	0	93,043
1966	3	2	1	0	115,295
1967	1	1	0	0	135,369
1968	1	0	1	0	167,193
1969	2	1	1	0	194,493
1970	2	1	1	0	194,732
1971	3	2	1	0	199,498
1972	3	1	2	0	195,942
1973	0	0	0	0	182,774
1974	0	0	0	0	168,444
1975	2	2	0	0	175,720
1976	3	3	0	0	163,492
1977	1	1	0	0	186,494
1978	1	1	0	0	210,545
1979	1	1	0	0	240,802
1980	1	1	0	0	198,611
1981	2	2	0	0	200,482
1982	2	2	0	0	231,456
1983	6	6	0	0	241,362
1984	2	1	1	0	260,119
1985	1	0	1	0	375,422
1986	4	2	1	1	493,447
1987	9	5	4	0	959,845
1988	6	2	4	0	967,692
total	60	40	21	1	6,629,854

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Delta Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	5	5	0	0	215,521
1965	1	1	0	0	233,057
1966	7	7	0	0	263,519
1967	4	3	1	0	288,875
1968	2	2	0	0	319,499
1969	10	9	1	0	373,621
1970	3	3	0	0	423,060
1971	6	4	2	0	430,775
1972	10	8	2	0	484,794
1973	8	7	1	0	560,178
1974	10	7	3	0	509,258
1975	8	6	2	0	512,431
1976	6	4	2	0	535,971
1977	3	3	0	0	558,720
1978	6	4	1	1	601,411
1979	4	1	3	0	642,041
1980	3	2	1	0	661,567
1981	4	3	1	0	665,432
1982	0	0	0	0	649,484
1983	1	0	1	0	666,098
1984	3	2	0	1	706,422
1985	7	7	0	0	740,387
1986	2	1	1	0	742,440
1987	6	6	0	0	1,064,383
1988	10	6	4	0	1,198,156
total	129	99	28	2	14,047,100

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Eastern Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	18	17	1	0	402,847
1965	13	12	1	0	417,634
1966	12	10	2	0	365,461
1967	14	11	3	0	486,056
1968	8	7	1	0	545,801
1969	13	10	3	0	612,663
1970	8	5	3	0	624,845
1971	9	5	4	0	636,749
1972	10	9	1	0	653,285
1973	8	7	1	0	684,308
1974	9	5	4	0	600,699
1975	8	7	1	0	641,077
1976	6	3	3	0	664,828
1977	6	4	2	0	680,945
1978	5	3	2	0	692,122
1979	2	2	0	0	725,991
1980	3	2	0	1	737,661
1981	9	7	2	0	711,985
1982	3	3	0	0	681,472
1983	7	4	1	2	711,994
1984	7	4	2	1	770,245
1985	6	4	2	0	787,921
1986	10	8	2	0	813,770
1987	10	7	3	0	786,767
1988	3	3	0	0	666,009
total	207	159	44	4	16,103,135

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

NorthWest Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	6	5	1	0	147,961
1965	4	2	2	0	170,434
1966	1	0	0	1	187,125
1967	1	1	0	0	250,665
1968	6	4	2	0	286,372
1969	0	0	0	0	319,600
1970	2	1	1	0	204,446
1971	7	6	0	1	250,879
1972	5	4	1	0	195,560
1973	2	2	0	0	266,220
1974	2	1	1	0	254,621
1975	2	1	1	0	247,597
1976	0	0	0	0	256,599
1977	1	1	0	0	261,980
1978	0	0	0	0	154,584
1979	0	0	0	0	266,743
1980	0	0	0	0	275,163
1981	5	5	0	0	272,648
1982	0	0	0	0	268,219
1983	1	1	0	0	300,621
1984	3	3	0	0	320,482
1985	2	2	0	0	357,120
1986	3	1	2	0	508,201
1987	4	3	1	0	835,486
1988	9	7	2	0	824,055
total	66	50	14	2	7,683,381

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Pan American Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	9	8	0	1	287,792
1965	7	5	0	2	320,997
1966	7	4	1	2	385,718
1967	9	6	1	2	466,942
1968	10	6	2	2	534,702
1969	9	7	0	2	540,925
1970	11	9	1	1	485,437
1971	7	6	0	1	457,327
1972	5	2	1	2	447,615
1973	4	2	1	1	471,282
1974	7	4	1	2	417,062
1975	4	2	2	0	363,570
1976	0	0	0	0	327,247
1977	3	1	1	1	309,192
1978	1	1	0	0	293,047
1979	5	3	1	1	292,298
1980	3	0	1	2	439,569
1981	3	3	0	0	398,513
1982	2	2	0	0	410,173
1983	2	2	0	0	373,584
1984	4	1	3	0	353,951
1985	0	0	0	0	331,888
1986	3	2	1	0	285,804
1987	4	2	2	0	312,630
1988	5	2	3	0	364,257
total	124	80	22	22	9,671,522

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Trans World Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	14	8	4	2	348,781
1965	7	6	1	0	403,289
1966	4	4	0	0	412,011
1967	7	6	1	0	528,992
1968	5	5	0	0	621,522
1969	9	7	2	0	694,349
1970	11	8	1	2	703,858
1971	8	5	3	0	674,630
1972	11	8	2	1	674,010
1973	4	2	2	0	612,358
1974	13	7	4	2	614,961
1975	8	7	1	0	597,666
1976	2	0	1	1	608,024
1977	2	2	0	0	617,284
1978	2	1	1	0	600,007
1979	2	2	0	0	599,199
1980	1	1	0	0	512,270
1981	1	1	0	0	432,053
1982	3	3	0	0	396,721
1983	7	5	1	1	411,915
1984	2	1	1	0	441,134
1985	1	1	0	0	466,360
1986	4	3	1	0	478,444
1987	3	2	1	0	570,382
1988	2	1	1	0	607,679
total	133	96	28	9	13,627,899

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

United Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	17	14	2	1	597,264
1965	15	9	3	3	661,152
1966	12	11	1	0	636,788
1967	19	17	2	0	809,078
1968	16	13	3	0	922,099
1969	12	9	3	0	963,734
1970	14	11	2	1	986,351
1971	14	10	2	2	916,048
1972	7	4	3	0	910,516
1973	3	3	0	0	908,331
1974	5	4	0	1	818,425
1975	5	5	0	0	768,504
1976	3	1	2	0	811,798
1977	6	4	2	0	849,573
1978	8	6	2	0	926,468
1979	2	1	1	0	814,627
1980	3	3	0	0	920,898
1981	5	3	1	1	758,373
1982	5	2	3	0	760,207
1983	11	8	3	0	833,093
1984	9	7	1	1	945,600
1985	2	2	0	0	826,534
1986	9	5	3	1	1,121,721
1987	7	5	2	0	1,222,937
1988	5	3	2	0	1,201,883
total	214	160	43	11	21,892,002

TABLE II

ACCIDENTS AND INCIDENTS FOR EIGHT AIRLINES
(continued)

Totals for Eight Airlines

year	total occurrences	controllable occurrences	uncontrollable occurrences	other occurrences	flying hours
1964	77	64	9	4	2,441,185
1965	61	45	11	5	2,691,129
1966	57	45	8	4	2,819,170
1967	60	48	10	2	3,507,054
1968	55	43	10	2	4,015,838
1969	56	44	10	2	4,336,713
1970	61	44	13	4	4,294,706
1971	66	48	14	4	4,224,634
1972	58	40	15	3	4,204,233
1973	39	30	8	1	4,346,571
1974	53	34	14	5	3,997,587
1975	46	36	10	0	3,936,489
1976	26	14	11	1	4,024,069
1977	27	20	6	1	4,135,728
1978	28	20	7	1	4,166,439
1979	21	14	5	2	4,329,449
1980	15	9	2	4	4,439,343
1981	32	27	4	1	4,049,954
1982	18	15	3	0	4,016,962
1983	43	32	6	5	4,197,657
1984	35	24	8	3	4,547,810
1985	31	25	6	0	4,744,502
1986	41	26	13	2	5,389,885
1987	57	36	21	0	6,921,046
1988	55	33	22	0	7,166,746
total	1118	816	246	56	106,944,899

Ordinary Least Squares Results

The first regression results are ordinary least squares (OLS) regressions. The regressions have been run using three data sets. The first two sets use fatal accident and all accident rates for all part 121 carriers. Also shown are regressions using controllable occurrences for the eight airlines (American, Continental, Delta, Eastern, Northwest, Pan Am, TWA, and United). Controllable occurrences are those accidents and incidents with causes that are under the airlines' control. The models are equations (2), (3), and (4) from the previous chapter and are repeated below for reader convenience. These and all subsequent regression results are obtained using the SHAZAM, econometrics computer program, DOS extended memory version 6.2.

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} \tag{2}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_3 \text{ Dummy} * \text{Time} \tag{3}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} + \beta_3 \text{ Dummy} * \text{Time} \tag{4}$$

The models are generic. The rate could be all fatal accidents for all Part 121 carriers divided by total hours flown by those carriers. Or, depending on the data set being used, the rate might be the number of occurrences with cause factors that are under the airlines' control divided by hours flown.

Regression Results The coefficients for time in the fatal accident models have the expected sign and are significantly different from zero. See Table III. The coefficients for the dummy variables are not significant. This is not unexpected given the thinness of the fatal accident statistics and it is consistent with the findings of other researchers (Rose, 1989: 100). Note the use of a zero dummy in the fatal accident model. This is used as an alternative formulation where a regression formula leads to a ln(0) problem. (There were no fatal accidents by Part 121 carriers in 1980.) This formulation was pioneered by Pakes and Griliches and by Hausman, Hall and Griliches. It will be discussed in later sections (Pakes and Griliches, 1980: 378) (Hausman, Hall and Griliches, 1984: 910).

The results from the controllable occurrence models and the models using all accidents are more instructive.

These results differ from Rose's 1989 results. She did not have data for 1987 and 1988 for her calculations. Also Rose tested the dummy variable for significance using 1978 as the year when deregulation began. As discussed in the last chapter I believe 1980 to be more appropriate. Rose did not use a dummy variable for time since deregulation, in her 1989 study (Rose, 1989: 99).

In the models using all accidents the coefficient for time is significant. The coefficient for the deregulation dummy has the expected sign, but is not significant. In the model using time since deregulation, the coefficient is significant at the five per cent level.

TABLE III

OLS RESULTS

Fatal Accidents

Dependent Variable = ln Fatal accident rate

	β_0	β_1	β_2	β_3
coefficient	5.95	-0.0832	-0.0408	
t-ratio	4.30††	-4.22††	-0.117	
R-square adjusted = 0.6943		Sum of Square Errors = 5.3371		
coefficient	5.47	-0.0762		-0.0367
t-ratio	4.11††	-4.04††		-0.608
R-square adjusted = 0.6990		Sum of Square Errors = 5.2558		
coefficient	5.70	-0.0797	0.279	0.0736
t-ratio	3.99††	-3.92††	0.517	0.783
R-square adjusted = 0.6891		Sum of Square Errors = 5.1925		

All Accidents

Dependent Variable = ln All accidents rate

	β_0	β_1	β_2	β_3
coefficient	8.41	-0.902	0.0285	
t-ratio	13.4††	-10.1††	0.187	
R-square adjusted = 0.9104		Sum of Square Errors = 1.1662		
coefficient	9.11	-0.100		0.0493
t-ratio	16.5††	-12.9††		1.95*
R-square adjusted = 0.9226		Sum of Square Errors = 1.0078		
coefficient	8.79	-0.0955	-0.249	0.0776
t-ratio	14.9††	-11.3††	-1.38	2.41†
R-square adjusted = 0.9254		Sum of Square Errors = 0.93054		

Controllable Occurrences

Dependent Variable = ln Controllable occurrence rate

	β_0	β_1	β_2	β_3
coefficient	8.54	-0.0888	0.480	
t-ratio	6.51††	-4.85††	1.75*	
R-square adjusted = 0.6165		Sum of Square Errors = 2.9506		
coefficient	10.2	-0.113		0.156
t-ratio	10.6††	-8.48††		4.65††
R-square adjusted = 0.7800		Sum of Square Errors = 1.6928		
coefficient	10.2	-0.112	-0.1039	0.157
t-ratio	9.27††	-7.30††	-0.421	3.95††
R-square adjusted = 0.7695		Sum of Square Errors = 1.69287		

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year
$\beta_2 \leftrightarrow$ deregulation dummy $\beta_3 \leftrightarrow$ time since deregulation

* significant at the 10% level † 5% level †† 1% level

In the regressions using controllable occurrences the coefficients all have the expected sign and all are significantly different from zero. The deregulation dummy in equation (2) is significant at the 10% level (one-tailed), while all others including the time since deregulation dummy are significant at the 1% level.

These results provide evidence that airline safety was affected by economic deregulation. Airline safety improved over time during the regulation era. Deregulation did not reverse that trend. However, the results of the OLS regressions indicate that the trend has slowed in the period since deregulation. This preliminary evidence is reason enough to look closer at the relationship between deregulation and airline safety.

DIFFICULTIES WITH THE OLS MODEL

Before the results of the OLS are accepted, there are some difficulties that need to be addressed. For the results of an OLS regression to be valid some assumptions need to be made about the data. The data presented here violate some of those assumptions. Specifically, the error terms are assumed to be normally distributed. Accident data, however, is ordinarily thought to follow a Poisson distribution. Also, the error terms are assumed to be uncorrelated. In this case, several firms react to the same economic conditions, in the same time periods. Under these circumstances, cross-sectional correlation of the error terms is a more reasonable assumption than uncorrelated error terms.

In addition to concerns about the error terms, there are the specification concerns discussed in the previous chapter. These include the possibility that the log form does not best model the safety to time relationship. There is also the concern that the true relationship includes a term that measures economic well-being of the airlines.

One last concern needs to be addressed before we can accept the OLS results. That is the problem raised by the model specification and the resulting need to substitute for the log(0). Each of these concerns will be addressed in subsequent sections.

Poisson Distribution and Maximum Likelihood Regressions

The Poisson distribution is characterized by discreet events occurring at random intervals. In a Poisson distribution, the number of events that occur in one time period is independent of the number of events occurring in other periods. The number of accidents in a certain period is a typical example of this distribution (McClave and Dietrich, 1982: 154). A number of researchers have applied this model to accident research (Rose, 1990: 950).

The appropriate regression technique for a Poisson distribution is a maximum likelihood technique like that used by the SHAZAM non-linear command (Hausman, Hall and Griliches, 1984: 912). Alternatively, the Poisson distributed variable could be transformed so that it assumes a normal distribution. Both techniques have been used in the literature. Rose used a maximum likelihood technique when she looked for a relationship between accident rates and economic well-being (Rose, 1990: 50).

Golbe took the square root of accidents to transform the distribution to a normal one. Golbe also sought a relationship between accident rates and economic well-being (Golbe, 1986: 312).

Results from both the maximum likelihood regression and OLS regressions using the square root of accident rates are shown below. They are similar to the results from the OLS regressions. See Table IV.

The maximum likelihood regression is the appropriate technique to use for the Poisson distribution. These regression results indicate that using the simpler OLS form does not overstate the case for a relationship between deregulation and airline safety.

TABLE IV

POISSON MODELS

Maximum Likelihood Results

Dependent Variable ln Fatal accident rate

	β_0	β_1	β_2	β_3
coefficient	5.70	-0.0797	0.279	-0.0736
t-ratio	4.38††	-4.30††	0.561	-0.858

Log-Likelihood function = -16.05

Dependent Variable ln All accident rate

	β_0	β_1	β_2	β_3
coefficient	8.79	-0.0954	-0.249	0.0776
t-ratio	16.0††	-12.2††	-1.49	2.53†

Log-Likelihood function = 7.154

Dependent Variable ln Controllable Occurrence rate

	β_0	β_1	β_2	β_3
coefficient	10.2	-0.112	-0.0103	0.157
t-ratio	9.87††	-7.75††	-0.451	4.25††

Log-Likelihood function = -1.816

Square Root Results

Dependent Variable square root Fatal accident rate

	β_0	β_1	β_2	β_3
coefficient	3.98	-0.0410	-0.302	0.0637
t-ratio	5.91††	-4.28††	-1.47	1.74*

R-Square Adjusted = 0.6605 Sum of Square Errors = 1.2069

Dependent Variable square root All accident rate

	β_0	β_1	β_2	β_3
coefficient	12.4	-0.135	-0.0827	0.120
t-ratio	20.1††	-15.4††	-0.439	3.58††

R-Square Adjusted = 0.9479 Sum of Square Errors = 1.0175

Dependent Variable square root Controllable Occurrence rate

	β_0	β_1	β_2	β_3
coefficient	15.3	-0.170	0.218	0.204
t-ratio	11.0††	-8.79††	0.701	4.09††

R-Square Adjusted = 0.8216 Sum of Square Errors = 2.6825

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year
$\beta_2 \leftrightarrow$ deregulation dummy $\beta_3 \leftrightarrow$ time since deregulation

* significant at the 10% level † 5% level †† 1% level

The Box-Cox Model

Accident rates have declined throughout aviation history. The data indicates a decaying function that approaches zero asymptotically. It is usual to assume the form is a log decay function. However there is no requirement that accidents should decay logarithmically. The formulation suggested by Box and Cox is appropriate when the exact form is not known.

The Box-Cox models from Chapter III are shown below. The results of the regressions for these models are shown in Table V.

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_2\ \text{Dummy} \tag{6}$$

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_3\ \text{Dummy} * \text{Transformed Time} \tag{7}$$

$$\text{Rate} = \beta_0 + \beta_1\ \text{Transformed Time} + \beta_2\ \text{Dummy} + \beta_3\ \text{Dummy} * \text{Transformed Time} \tag{8}$$

The Box-Cox results are similar to the results obtained using the log form. This similarity indicates that the log form is an adequate representation of the true relationship between safety and time.

The Cross-sectional Model

The data fits the form of a cross-sectionally correlated and time-wise auto-regressive model described by Kmenta (Kmenta, 1986: 622). There is a difficulty using the log form of the equation, however.

TABLE V

BOX-COX RESULTS

Dependent Variable ln Fatal accident rate

	β_0	β_1	β_2	β_3
coefficient	**6.14**	**-0.0832**	**-0.3.12**	**0.0852**
t-ratio	5.51††	-5.25††	-0.907	1.39

R-square adjusted = 0.6987 Sum of Square Errors = 3.6999

Dependent Variable ln All accident rate

	β_0	β_1	β_2	β_3
coefficient	**21.6**	**-0.254**	**-0.161**	**0.221**
t-ratio	19.0††	-15.8††	-0.462	3.57††

R-square adjusted = 0.9474 Sum of Square Errors = 3.6556

Dependent Variable ln Controllable Occurrences rate

	β_0	β_1	β_2	β_3
coefficient	**20.3**	**-0.236**	**0.293**	**0.288**
t-ratio	12.5††	-10.5††	0.787	4.90††

R-square adjusted = 0.8238 Sum of Square Errors = 5.2791

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year
$\beta_2 \leftrightarrow$ deregulation dummy $\beta_3 \leftrightarrow$ time since deregulation

†† significant at the 1% level

The data is such that when one separates the accidents/incidents out by airline the occurrence rate is often zero for a given year. Rose addresses this problem and suggests the form used by Griliches et al. (Rose, 1989: 99) (Pakes and Griliches, 1980: 378) (Hausman, Hall and Griliches, 1984: 910).

This method requires using a zero dummy. This dummy is set to '1' where the rate is zero and '0' where the rate is non-zero. A transformed rate is then calculated. This transformed rate does not have zeroes. The transformed rate is equal to the original rate plus the zero dummy* (Hausman, Hall and Griliches, 1984: 910).

Griliches suggests selecting the data set to reduce the number of occurrences of zeroes, to preferably less than ten percent (Hausman, Hall and Griliches, 1984: 910). The data set in use here does not fit that description. It is, however, possible to select airlines for which the data does fit that criteria. By eliminating Continental, NorthWest, and Pan Am from the data sample we are left with only the five largest airlines. The resulting data set fits the criteria. In this truncated data set, zero occurs in only three per cent of the data points.

The regression results of a pooled cross-sectionally correlated and time-wise auto-regressive model are shown in Table VI.

It is also possible to transform the rate to eliminate the log(0) problem. This creates a new problem, in that there is no theoretical basis for the form of the transformation. One can make some pertinent observations though.

If the rate is transformed by adding a very small number, (10^{-6}) the log can be taken. This seems at first to be a good transformation in that it requires little change to the data. However, this creates another problem. The

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* One disadvantage to this transformation is that it does not preserve the ordering of the data.

TABLE VI

CROSS-SECTIONAL RESULTS

Dependent Variable = ln Controllable Occurrence rate [ln((Occurrences + 1)/hours)]

	β_0	β_1	β_2	β_3
coefficient	9.21	-0.0960	0.0844	0.116
t-ratio	12.7††	-9.47††	0.541	4.46††

Buse Raw-moment R-square = 0.9438   Sum of Square Errors = 167.57

Dependent Variable = ln Controllable Occurrence rate (modified rate) (Five airlines only)

	β_0	β_1	β_2	β_3	β_5
coefficient	10.2	-0.113	0.115	0.124	-1.55
t-ratio	10.2††	-8.06††	0.515	3.39††	-5.41††

Buse Raw-moment R-square = 0.9209   Sum of Square Errors = 99.747

Dependent Variable = ln Controllable Occurrence rate [ln((Occurrences + 1)/hrs)] (Five airlines only)

	β_0	β_1	β_2	β_3
coefficient	9.93	-0.107	0.101	0.128
t-ratio	11.1††	-8.53††	0.527	3.99††

Buse Raw-moment R-square = 0.9449   Sum of Square Errors = 104.51

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year $\beta_2 \leftrightarrow$ deregulation dummy
$\beta_3 \leftrightarrow$ time since deregulation $\beta_5 \leftrightarrow$ zero dummy

†† significant at the 1% level

"zero points" become outliers. In fact, regressions run using this kind of transformation give coefficients and t-ratios for time that are much different from those expected.

By adding a larger number to the number of occurrences, one for instance, the data remains smooth and the regression coefficients have the expected signs and t-ratios. While this is not particularly satisfying from a theoretical standpoint, it does have the advantage of making the pooled cross-sectional analysis possible. Also the results are similar to those obtained using the Box-Cox transformation.*

OPERATING RATIO

If the airlines' economic health is a determinant in airline safety, some measure of economic health should be included in the formulation. Omitting variables from regression models can make the remaining variables appear to be more significant than they really are. Many observers suggested that deregulation would adversely affect the airlines' economic health. Some researchers have found links between airline economic well-being and safety (Rose, 1990: 953). In that case, omitting economic well-being could easily make the dummy for deregulation appear significant when it really is not.

* This transformation preserves the data ordering and does not introduce any obvious problems with respect to the residuals. Plots of the residuals are shown in Appendix H.

To test this hypothesis the regressions from equations (9) and (10) were run. The equations are shown below.

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} + \beta_4 \text{ Opratio} \tag{9}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_3 \text{ Dummy} * \text{Time} + \beta_4 \text{ Opratio} \tag{10}$$

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} + \beta_3 \text{ Dummy} * \text{Time} + \beta_4 \text{ Opratio} \tag{11}$$

The variable "opratio" is the ratio of operating expenses divided by operating revenue and is lagged one period.* Operating ratio is used to measure economic well-being. To the extent that safety improvements require capitalization, the use of return on investment could obscure the profitability-safety relationship. Operating ratio also has the advantage that it does not include the non-airline business of the airline holding companies. The other variables are as before.

The results of these regressions are shown in Table VII. The operating ratio is not significant in either form. the deregulation dummy is significant in both forms. The operating ratio results confirm Rose's results. She found that economic well-being was not a significant factor in determining safety for larger airlines. She obtained these results using data from all Part 121 carriers. However, she found that the effects varied for different carrier groups.

* Operating ratio is used as the measure of economic well-being to avoid problems with other measures. Return on investment can obscure the safety-profit relationship where safety improvements are imbedded in capital (Golbe, 1986: 312). Operating ratio as used here has the additional value of focusing on the airline operation and not on other activities of the airline holding companies.

TABLE VII

OPERATING-RATIO RESULTS

Dependent Variable = ln Controllable Occurrence rate [ln((Occurrences + 1)/hours)]

	β_0	β_1	β_2	β_3	β_4
coefficient	11.3	-0.1208	0.144	0.147	-0.169
t-ratio	5.87††	-5.52††	0.872	4.73††	-0.1939

Buse Raw-moment R-square = 0.9461 Sum of Square Errors = 103.50

Dependent Variable = ln Controllable Occurrence rate (modified rate) (Five airlines only)

	β_0	β_1	β_2	β_3	β_4	β_5
coefficient	14.4	-0.156	0.221	0.172	-0.850	-1.59
t-ratio	5.51††	-6.39††	0.942	3.94††	-0.631	-6.39††

Buse Raw-moment R-square = 0.9195 Sum of Square Errors = 58.672

Dependent Variable = ln Controllable Occurrence rate [ln((Occurrences + 1)/hrs)] (Five airlines only)

	β_0	β_1	β_2	β_3	β_4
coefficient	12.2	-0.122	0.147	0.145	-1.05
t-ratio	4.72††	-4.30††	0.683	3.51††	-0.772

Buse Raw-moment R-square = 0.9387 Sum of Square Errors = 64.549

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year $\beta_2 \leftrightarrow$ deregulation dummy
$\beta_3 \leftrightarrow$ time since deregulation $\beta_4 \leftrightarrow$ operating ratio $\beta_5 \leftrightarrow$ zero dummy

†† significant at the 1% level

For the largest airlines operating ratio did not have a clear effect on safety, while for the smaller airlines there was a profitability effect. For the smaller airlines high profitability had a favorable effect on safety (Rose, 1990: 955).

The regressions were also run using an un-lagged form. (See the appendix.) The results were similar. The operating ratio results confirm earlier work by Golbe (Golbe, 1986: 314).

These results indicate that the original formulation was not harmed by the omission of the operating ratio.

OTHER TESTS

CUSUM Test

Another test for structural changes in regression models is the CUSUM or cumulative sum of residuals test. The output from this test is shown in Table VIII. The test was performed three times, using fatal accidents, all accidents, and accidents and incidents that were under the airlines' control.

The fatal accident and all accident models showed no indication of structural change. The model, using occurrences under the airlines' control, goes outside the 10% significance bounds in the last year. A plot of the recursive residuals is shown in Figure 1.

TABLE VIII

CUSUM RESULTS

DEPENDENT VARIABLE = LNCRATE 25 OBSERVATIONS
REGRESSION COEFFICIENTS -0.622288231606E-01 6.69122759973
RECURSIVE COEFFICIENT ESTIMATES RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 5%

			OBS	YR	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
2	-0.44970	32.047								
3	-0.24809	19.077	3	66	0.16461	0.48425	4.9418	-0.29105	0.00807	0.37801
4	-0.19964	15.944	4	67	0.08845	0.74446	5.3371	-0.24757	0.01039	0.42149
5	-0.19912	15.910	5	68	0.00165	0.74933	5.7325	-0.20410	0.01040	0.46497
6	-0.17822	14.545	6	69	0.10095	1.04629	6.1278	-0.16062	0.01343	0.50844
7	-0.15062	12.732	7	70	0.18855	1.60096	6.5232	-0.11714	0.02401	0.55192
8	-0.11794	10.576	8	71	0.29946	2.48189	6.9185	-0.07366	0.05070	0.59540
9	-0.10667	9.8274	9	72	0.13345	2.87447	7.3139	-0.03018	0.05600	0.63888
10	-0.11261	10.224	10	73	-0.08822	2.61495	7.7092	0.01329	0.05832	0.68236
11	-0.10125	9.4623	11	74	0.20651	3.22245	8.1045	0.05677	0.07101	0.72584
12	-0.08800	8.5706	12	75	0.28914	4.07302	8.4999	**0.10025**	**0.09590**	0.76931
13	-0.10896	9.9886	13	76	-0.54136	2.48049	8.8952	0.14373	0.18313	0.81279
14	-0.10961	10.033	14	77	-0.01962	2.42275	9.2906	**0.18721**	**0.18325**	0.85627
15	-0.10748	9.8871	15	78	0.07427	2.64125	9.6859	**0.23069**	**0.18489**	0.89975
16	-0.11239	10.225	16	79	-0.19585	2.06511	10.0813	**0.27416**	**0.19631**	0.94323
17	-0.12272	10.937	17	80	-0.46636	0.69320	10.4766	**0.31764**	**0.26104**	0.98671
18	-0.10693	9.8423	18	81	0.80273	3.05462	10.8719	0.36112	0.45284	1.03018
19	-0.10309	9.5748	19	82	0.21824	3.69663	11.2673	0.40460	0.46702	1.07366
20	-0.08862	8.5622	20	83	0.91376	6.38467	11.6626	0.44808	0.71555	1.11714
21	-0.08153	8.0640	21	84	0.49461	7.83970	12.0580	0.49156	0.78837	1.16062
22	-0.07527	7.6211	22	85	0.48159	9.25640	12.4533	0.53503	0.85740	1.20410
23	-0.07064	7.2926	23	86	0.38946	10.40210	12.8487	0.57851	0.90255	1.24757
24	-0.06562	6.9342	24	87	0.46130	11.75912	13.2440	0.62199	0.96589	1.29105
25	-0.06222	6.6912	25	88	0.33853	12.75497	13.6393	0.66547	1.00000	1.33453

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = 2.6596 WITH 22 D.F.
HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 9.7699 WITH M = 7

TABLE VIII

CUSUM RESULTS
(continued)

DEPENDENT VARIABLE = LNACCRAT 27 OBSERVATIONS
REGRESSION COEFFICIENTS -0.888459968996E-01 8.32313497880
RECURSIVE COEFFICIENT ESTIMATES RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 5%

			OBS	YR	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
2	-0.29379	20.815								
3	-0.09340	8.5249	3	63	0.16361	0.74166	5.1192	-0.28368	0.02292	0.36368
4	-0.03265	4.7782	4	64	0.11093	1.24450	5.4984	-0.24368	0.03345	0.40368
5	-0.00975	3.3588	5	65	0.07239	1.57268	5.8776	-0.20368	0.03794	0.44368
6	-0.02865	4.5366	6	66	-0.09127	1.15893	6.2568	-0.16368	0.04507	0.48368
7	-0.05243	6.0267	7	67	-0.16243	0.42259	6.6360	-0.12368	0.06766	0.52368
8	-0.06448	6.7862	8	68	-0.11050	-0.07833	7.0152	-0.08368	0.07812	0.56368
9	-0.07637	7.5393	9	69	-0.14068	-0.71606	7.3944	-0.04368	0.09506	0.60368
10	-0.08652	8.1854	10	70	-0.15054	-1.39848	7.7736	-0.00368	0.11447	0.64368
11	-0.08754	8.2504	11	71	-0.01844	-1.48209	8.1528	0.03632	0.11476	0.68368
12	-0.08185	7.8842	12	72	0.12427	-0.91877	8.5320	0.07632	0.12798	0.72368
13	-0.08515	8.0981	13	73	-0.08541	-1.30599	8.9112	0.11632	0.13423	0.76368
14	-0.07759	7.6065	14	74	0.22815	-0.27176	9.2904	0.15632	0.17879	0.80368
15	-0.07950	7.7310	15	75	-0.06640	-0.57279	9.6696	**0.19632**	**0.18257**	0.84368
16	-0.08652	8.1923	16	76	-0.27981	-1.84121	10.0488	0.23632	0.24960	0.88368
17	-0.09225	8.5703	17	77	-0.25868	-3.01387	10.4280	0.27632	0.30690	0.92368
18	-0.09533	8.7750	18	78	-0.15685	-3.72488	10.8072	0.31632	0.32796	0.96368
19	-0.09549	8.7854	19	79	-0.00888	-3.76514	11.1864	**0.35632**	**0.32803**	1.00368
20	-0.10056	9.1245	20	80	-0.31974	-5.21456	11.5656	0.39632	0.41556	1.04368
21	-0.09592	8.8126	21	81	0.32351	-3.74803	11.9448	0.43632	0.50517	1.08368
22	-0.09712	8.8939	22	82	-0.09233	-4.16658	12.3240	0.47632	0.51247	1.12368
23	-0.09316	8.6248	23	83	0.33308	-2.65665	12.7032	0.51632	0.60746	1.16368
24	-0.09637	8.8438	24	84	-0.29428	-3.99065	13.0824	0.55632	0.68161	1.20368
25	-0.09537	8.7752	25	85	0.09976	-3.53841	13.4616	0.59632	0.69013	1.24368
26	-0.09377	8.6652	26	86	0.17248	-2.75655	13.8408	0.63632	0.71560	1.28368
27	-0.08884	8.3231	27	87	0.57633	-0.14393	14.2200	0.67632	1.00000	1.32368

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = -0.0288 WITH 24 D.F.
HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 5.8704 WITH M = 8

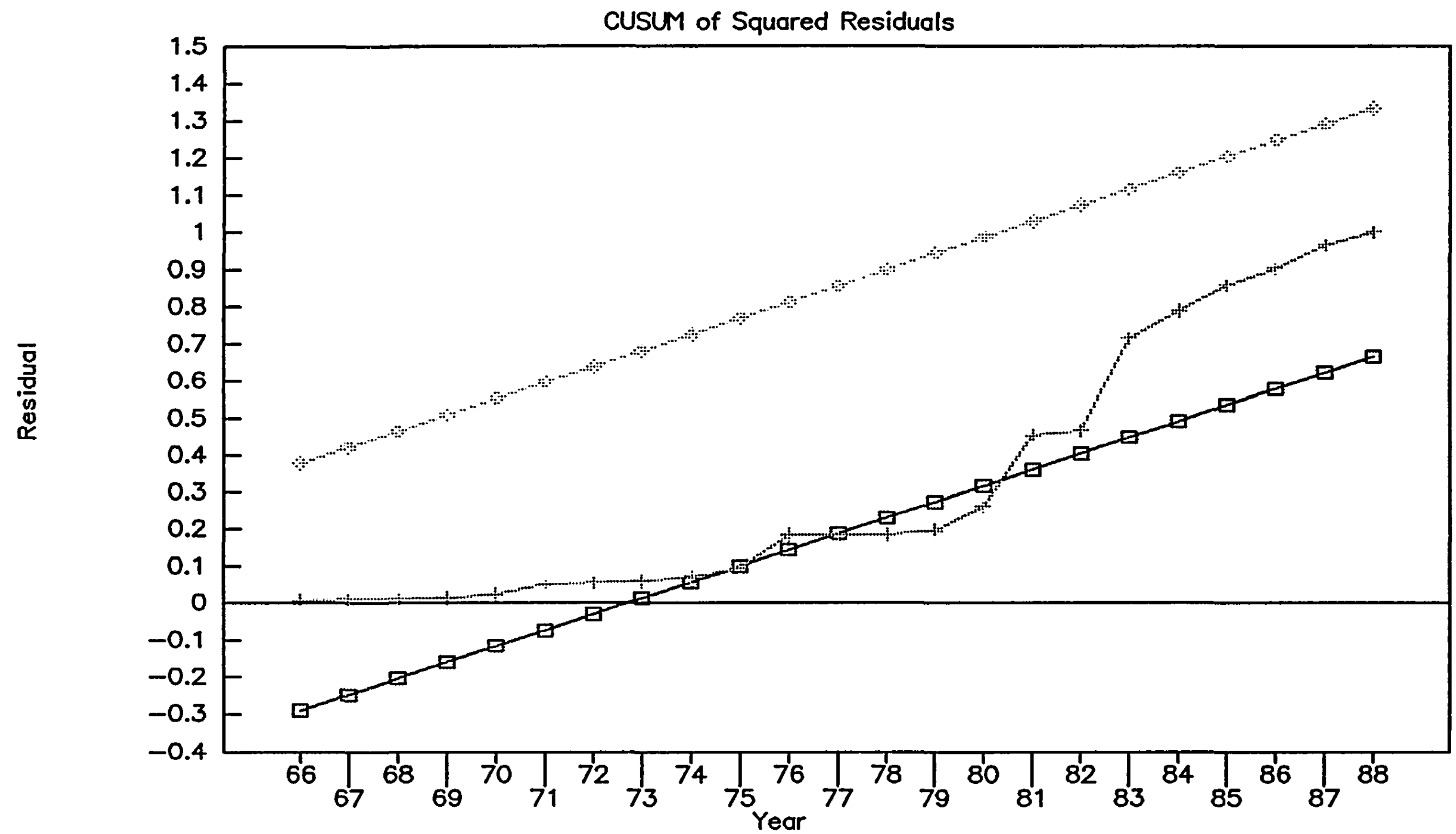

Figure 1. CUSUM of Squared Residuals.

These results are not conclusive. However, they are not inconsistent with the results of the OLS regressions.

Coincidence of the Structural Change and the Date of Deregulation

We have seen that there is an apparent structural change in the model near the time of deregulation. The question remains then, is 1980 the date of this apparent change? One obvious way to test this is to simply run the regressions using different dates for the dummy variable.

Results of such an exercise are shown below in Table IX. From the table one can see that any of the years 1978 through 1980 appear to fit the data quite well.

The time frame 1978 through 1980 fits the date of deregulation well. CAB chairman, John Robson began to relax some of the regulatory restrictions as early as 1976. Alfred Kahn, his successor, continued the process. The airlines could not be fully deregulated without legislation, however. The legislation was passed and signed into law in October 1978. The law provided for a seven-year phase in period. The CAB, however, had completely deregulated the industry by the end of 1979 (Caves, Christensen, Tretheway and Windle, 1987: 286).

1980 then was the first full year after deregulation was complete. Some of the early changes in regulatory posture certainly affected the industry as early as 1978.

TABLE IX

CONTROLLABLE OCCURRENCES WITH VARIOUS DUMMY YEARS

	VARIABLE NAME	CONSTANT	TIME	DUMMY	TIMEDUM	R-SQUARE	SSE
Year	COEFFICIENT	9.64	-0.1026	-0.208	0.0993	0.9414	167.47
75	T-RATIO	7.80††	-5.73††	-1.42	4.45††		
Year	COEFFICIENT	8.23	-0.0815	-0.505	0.1035	0.9448	167.39
76	T-RATIO	7.73††	-5.33††	-3.54††	4.95††		
Year	COEFFICIENT	9.90	-0.1062	-0.0696	0.1134	0.9438	167.31
77	T-RATIO	10.3††	-7.72††	-0.477	5.38††		
Year	COEFFICIENT	9.56	-0.1011	-0.0565	0.115	0.9434	167.45
78	T-RATIO	10.9††	-8.17††	-0.380	5.24††		
Year	COEFFICIENT	9.06	-0.0938	-0.118	0.1222	0.9430	167.53
79	T-RATIO	11.3††	-8.36††	-0.776	5.17††		
Year	COEFFICIENT	9.21	-0.0961	0.0844	0.1161	0.9438	167.57
80	T-RATIO	12.7††	-9.47††	0.540	4.46††		
Year	COEFFICIENT	9.76	-0.1042	0.662	0.0601	0.9461	167.47
81	T-RATIO	15.0††	-11.6††	4.24††	2.08†		
Year	COEFFICIENT	8.50	-0.0859	0.316	0.0797	0.9441	167.63
82	T-RATIO	13.7††	-10.1††	1.84*	2.24†		
Year	COEFFICIENT	8.34	-0.0837	0.598	0.0224	0.9376	167.82
83	T-RATIO	13.8††	-10.2††	3.22††	0.499		
Year	COEFFICIENT	7.53	-0.0718	0.183	0.0826	0.9322	167.80
84	T-RATIO	12.8††	-8.98††	0.874	1.38		
Year	COEFFICIENT	7.20	-0.0671	0.0921	0.1096	0.9283	167.83
85	T-RATIO	12.7††	-8.76††	0.394	1.33		

* significant at the 10% level † 5% level †† 1% level

UNCONTROLLABLE OCCURRENCES

As a final exercise I have regressed the occurrences that are not under the airlines' control on time and the dummy for deregulation. I used equation (4), shown below.

$$\ln(\text{Rate}) = \beta_0 + \beta_1 \text{ Time} + \beta_2 \text{ Dummy} + \beta_3 \text{ Dummy} * \text{Time} \quad (4)$$

This equation reduces to equation (1) for time periods prior to deregulation. It can also be rearranged as follows for periods after deregulation.

$$\ln(\text{Rate}) = (\beta_0 + \beta_2) + (\beta_1 + \beta_3) * \text{Time} \quad (12)$$

The regression results are shown in Table X. Looking at the table, one can see that the dummy coefficient is small compared to the constant term. While the coefficient for the term for time times dummy, (TIMEDUM), is large compared to the coefficient for the time variable, (YEAR). This can also be seen, graphically in Figure 2. The results are disturbing. As we have seen from earlier regressions, the rate of improvement in airline safety slowed during the period since deregulation. The large positive coefficient on the variable TIMEDUM implies that the occurrences not under the airlines' control have fared even worse.

Economic deregulation cannot explain these results. Moses and Savage suggest that the infrastructure is an important factor that can affect airline safety. The increases in flying activity brought on by deregulation require additional investment in the infrastructure. They suggest that the government might not have invested enough

TABLE X

OCCURRENCES NOT UNDER THE AIRLINES' CONTROL

Dependent Variable ln uncontrollable occurrence rate

	β_0	β_1	β_2	β_3
coefficient	4.71	-0.0528	-1.299	0.274
t-ratio	4.65††	-3.74††	-.570	7.50††

R-Square Adjusted = 0.7756
Sum of Squared Errors = 1.4275

$\beta_0 \leftrightarrow$ constant $\beta_1 \leftrightarrow$ year $\beta_2 \leftrightarrow$ deregulation dummy

$\beta_3 \leftrightarrow$ time since deregulation

* significant at the 10% level † 5% level †† 1% level

to meet this increased need for infrastructure. Without this investment, the aviation industry cannot achieve the optimum level of safety (Moses and Savage, 1990: 174).

Appropriate investment in the infrastructure is needed to obtain the high levels of safety we expect. The regression results suggest that this level of investment is not being provided.

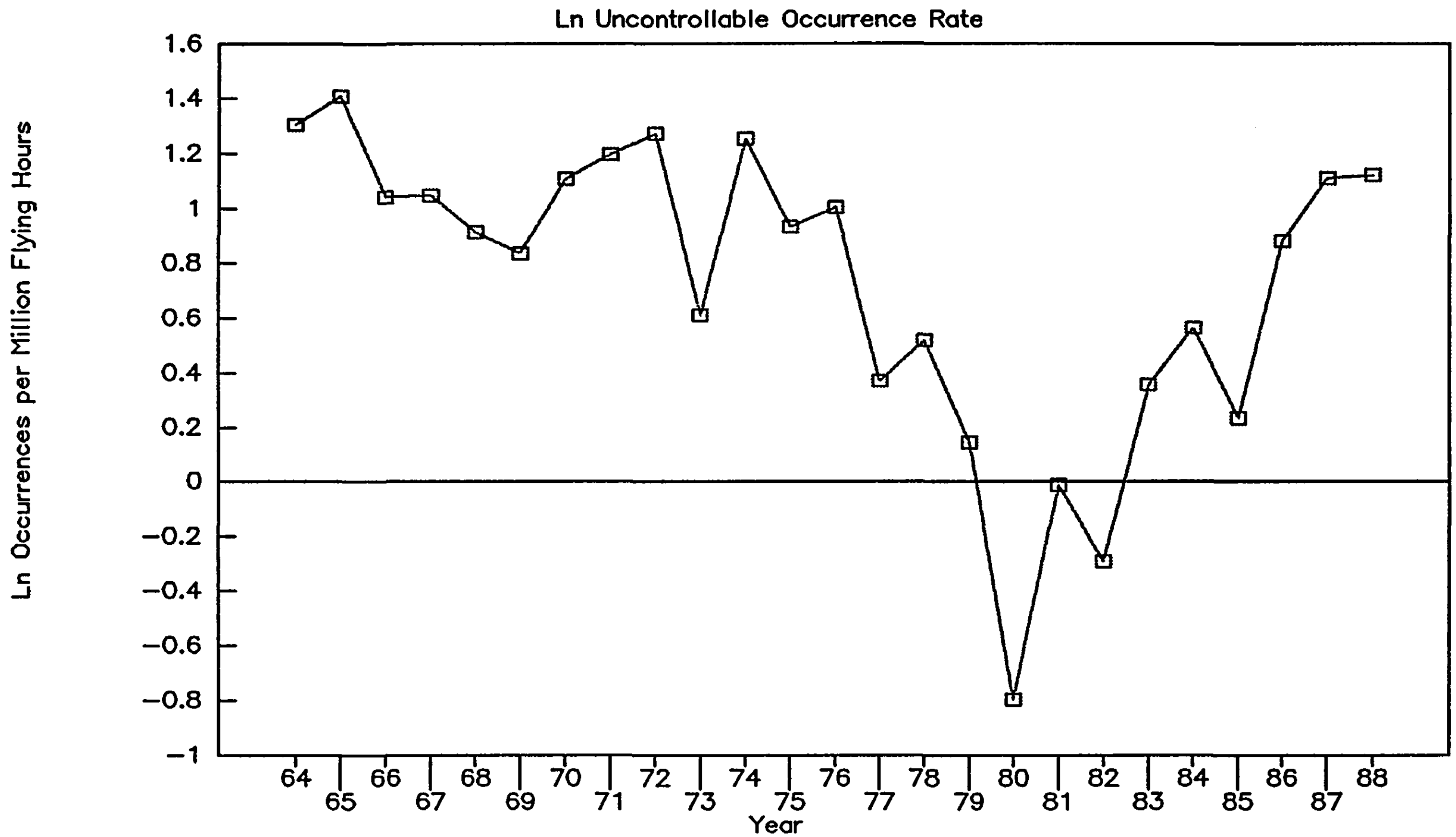

Figure 2. ln Uncontrollable Occurrence Rate.

CHAPTER V

CONCLUSIONS

There has not been a decrease in safety levels since deregulation. Safety levels have continued to improve since then. The question, however, is "Are safety levels as high as they would be if the industry were still regulated?"

HYPOTHESIS

Null Hypothesis

The original question to be answered with this study concerned the effect of deregulation on airline safety. The Null Hypothesis was "Economic deregulation of the airlines has had no effect on airline safety." To test this hypothesis I focused primarily on the safety records of those eight trunk airlines that existed throughout the test period.

Other researchers have looked at the effect of new entrants. New entrants, as a group, are not as safe as the established airlines (Barnett and Higgins, 1989: 16). Others have also looked at the effects of expanding the commuters' share of the market. The smaller commuter lines are not as safe as the major carriers. However, the larger commuters have safety records approaching those of the majors (Oster and Zorn, 1983: 9).

The major trunk lines dominate the airline industry. The eight largest trunks controlled 86.5% of the market in 1987 (Borenstein, 1992: 47). Since the major trunks dominate the industry, it is important to see how deregulation affected this portion of the industry. The effect of deregulation on the trunks is the effect that has the greatest impact on the traveling public.

To answer this question I began with a simple OLS regression model of safety on time with a dummy for deregulation. The regression results indicated that safety had been adversely affected by deregulation. There were several potential problems with these first results.

Regression Issues

One of the OLS model assumptions is that the distribution of the error terms is normal. Since accidents occur with a Poisson distribution, this assumption is violated. The use of maximum likelihood techniques showed that the OLS model did not overstate the case for an adverse affect from deregulation.

The OLS assumption of no correlation of the error terms is violated by using cross-sectional data from the several firms in the study. Regression results from the pooled cross-sectionally correlated and time-wise auto-regressive model formulation indicate that the OLS results were not invalidated by making this assumption.

There is no theoretical reason to assume that the log form of the equation is the correct formulation. The regression results from the Box-Cox formulation show that the log form is a good approximation. These results also confirm the OLS results that indicate an adverse effect from deregulation.

The use of the log form created problems where there were no occurrences for some data points. In these cases the log formulation called for taking the log of zero. This problem was "solved" in three different ways. First, use was made of a "zero dummy." Here at each occurrence of log(0), the data point was replaced by log(1) and the "zero dummy" was set equal to one. The second "solution" involved modifying all the data points by adding a constant so that all rates were positive. The third was the use of the Box-Cox formulation. Each of these approaches confirmed the initial OLS results. Table XI shows a comparison of the different formulations and techniques.

TABLE XI

COMPARISON OF REGRESSION RESULTS

	β_0	β_1	β_2	β_3	β_4	β_5	R^2 &SSE
All Accidents							
Ordinary Least Squares Results							
coef	8.79	-0.0955	-0.249	0.0776			0.9254
t-ratio	14.9††	-11.3††	-1.38	2.41†			0.9305
Controllable Occurrences							
	β_0	β_1	β_2	β_3	β_4	β_5	R^2 &SSE
Ordinary Least Squares Results							
coef	10.2	-0.112	-0.1039	0.157			0.7695
t-ratio	9.27††	-7.30††	-0.421	3.95††			1.6928
Box-Cox Results							
coef	20.3	-0.236	0.293	0.288			0.8238
t-ratio	12.5††	-10.5††	0.787	4.90††			5.2791
Maximum Likelihood Results							
coef	10.2	-0.112	-0.0103	0.157			
t-ratio	9.87††	-7.75††	-0.451	4.25††	Log-Likelihood function		-1.816
Square Root Results							
coef	15.3	-0.170	0.218	0.204			0.8216
t-ratio	11.0††	-8.79††	0.701	4.09††			2.6825
Cross-Sectional Results							
coef	9.21	-0.0960	0.0844	0.116			0.9438
t-ratio	12.7††	-9.47††	0.541	4.46††			167.57
Cross-Sectional Results with zerodummy							
coef	10.2	-0.113	0.115	0.124		-1.55	0.9209
t-ratio	10.2††	-8.06††	0.515	3.39††		-5.41††	99.747
Operating-ratio Results							
coef	11.3	-0.1208	0.144	0.147	-0.169		0.9461
t-ratio	5.87††	-5.52††	0.872	4.73††	-0.1939		103.50
Operating-ratio Results with zerodummy							
coef	14.4	-0.156	0.221	0.172	-0.850	-1.59	0.9195
t-ratio	5.51††	-6.39††	0.942	3.94††	-0.631	-6.39††	58.672

$\beta_0 \leftrightarrow$ constant $\quad$ $\beta_1 \leftrightarrow$ year $\quad$ $\beta_2 \leftrightarrow$ deregulation dummy

$\beta_3 \leftrightarrow$ time since deregulation $\quad$ $\beta_4 \leftrightarrow$ operating ratio $\quad$ $\beta_5 \leftrightarrow$ zero dummy

* significant at the 10% level † 5% level †† 1% level

Formulation Issues

It is possible with the simple model of safety regressed on time that important independent variables might be left out of the model. One of the issues often considered as a result of deregulation is increasing fleet age. The competitive pressures of the deregulated industry have increased the age of aircraft in the fleet.

Other researchers have found that the average age of aircraft involved in accidents has not gone up as fast as the average age of the fleet (Winston and Morrison, 1988: 11). This indicates that older airplanes are not causing safety problems. Therefore leaving fleet age out of the model does not change the results.

Changes in hiring practices for pilots are also cited as a factor in airline safety. How the increased age of airline new hires might affect safety is not clear. Some argue that older pilots might not retain the skills necessary to cope with emergency situations. Others argue that older pilots might be more experienced and therefore safer. Again as with fleet age the average age of pilots involved in accidents has gone up. It has not gone up as fast as the average age of all pilots, nor is the change statistically significant (Morrison and Winston, 1988: 11). Morrison and Winston also found that flying experience of pilots involved in accidents has gone up during the deregulation era. They measured experience both as total flying hours and as hours in aircraft type (Morrison and Winston, 1988: 11). Therefore, the results of our regressions should not be affected by leaving out pilot age as a factor.

Economic-well being of the airlines is a consideration that is often cited as a possible determinant of airline safety. Rose found that in some cases it did affect safety. Economic well-being* was included in an alternative formulation of the model. The regression results from this model indicated that in this case economic well-being was not a determinant of safety. Its inclusion or omission did not affect the results.

Data Problems

The data set is not ideal. Fatal accidents are the kinds of occurrences that concern travelers and terrorize board rooms. However, measuring safety using fatal accident statistics is difficult. Fatal accidents are simply too rare. Using all accidents as a measure of safety seems reasonable. Minor accidents have the same kinds of causes and the difference between a minor accident and tragedy often seems a matter of luck. Many other researchers have used this approach.

*Rose used operating margin which she defined as one minus the operating ratio. I used operating ratio as the measure of economic well-being.

In this study, that approach was extended to include all incidents investigated by the NTSB. Rose objected to this extension. She states that most accidents are caused by pilot error, maintenance problems or training deficiencies. These cause categories are clearly factors under the airlines' control. She suspected that incidents are likely to contain a higher proportion of occurrences with cause factors like air traffic control error. Thus, a higher percentage of these occurrences would be caused by factors not under the airlines' control (Rose, 1989: 96).

In this study I have divided the occurrences into those with cause factors that are under the airlines' control and those with cause factors not under their control. This eliminates that difficulty with incident data. There is another difficulty.

Dozens of incidents are reported every year. This data is on-line for the years after 1980. For prior years it is not available on-line. Nor is the data available at all from any one source. What is available, is computer listings of those incidents investigated by the NTSB.

The NTSB investigates those incidents that are deemed to be of particular interest from a safety standpoint. To the extent that this is accomplished, this pre-sorting by the NTSB should improve the usefulness of the data set. However, there is the possibility that the NTSB has, from time to time, for organizational or safety or other reasons, changed the way it selects incidents to investigate.

If there was a problem with incident data, the regressions using incident data should differ from those using accident data. However, regression results for models using all accidents and models using incidents and accidents do not differ greatly. The difference of interest is in the significance of the coefficient on the deregulation dummies. The increased sample size obtained by using incidents and accidents provides more statistical power. While the dummy variables are significant at the five or ten per cent level using accident data, they are significant at the one per cent level using incidents and accidents. This additional statistical power was the reason for using incidents.

Other Factors and Timing

There is also the possibility that the change in safety levels implied by these findings was caused by some factor other than deregulation. The air traffic control strike and the controllers' subsequent dismissal is often cited as a factor that might have affected safety. Using only those occurrences that are caused by factors under the airlines' control is one technique that was used to eliminate that concern.

If the structural change in the model was caused by deregulation, the change should occur within a reasonable time after deregulation. Two techniques were used to test for timing. The results of the CUSUM test were not conclusive.

The second method used was the simple expedient of checking to see if moving the dummy variables in time provided a better fit. The results of this simple experiment showed that the timeframe 1979-1980 best captured the structural change found. This fits with the 1978 passage of the airline deregulation act. All observers note that deregulation had actually begun before the bill was signed. Bailey notes that deregulation was in complete effect by January 1979 (Bailey and Panzar, 1981: 130). Again the results fit well with these observations.

CONCLUSIONS

The initial results from the simplest model using the simplest regression technique suggested that deregulation has adversely affected safety. Issues including OLS assumptions, model formulation, and data problems were raised and addressed. In every case the resulting regression model gave the same results. The coefficient for the dummy for time since deregulation is positive and significant. Only for the models using fatal accidents were the results ambiguous.

It is possible that some factor has been overlooked. It is possible some other factor is the cause of these statistical results. But, every effort has been made to eliminate other possibilities and I feel compelled to conclude that deregulation adversely affected airline safety. This adverse effect amounts to approximately seven or eight additional fatal accidents since deregulation.

Other Concerns

Airline safety did not improve after deregulation at the same pace as before deregulation. This was true for occurrences with cause factors under the control of the airlines. It was also true for those incidents and accidents with cause factors that were not under the airlines' control. Those occurrences not under the control of the airlines fared more poorly than those under their control.

Some of the problems that raised the rate of occurrences that were not under the airlines' control had to do with infrastructure. Airport and airway facilities and air traffic control did not fare well under deregulation. The increased traffic generated by deregulation was not matched by a corresponding increase in investment in infrastructure. The results from the model using uncontrollable occurrences indicates that the investment probably should have been made.

Recommendations

Economics is not an interesting science, if it has no relevant input into policy making. I will, therefore, hazard some recommendations based on observations made in this study.

The benefits to the consumer of airline deregulation were calculated by Morrison and Winston to be roughly six billion dollars per year (Morrison and Winston, 1990: 390). Even if this figure is far too large, clearly, we can spend our safety dollars more effectively than by returning to a 1960's style regulation of the airline industry.

The following is sometimes suggested as a mechanism for a deregulation effect on safety. Deregulation increases competitive pressure. The increased competitiveness decreases profitability. Decreased profitability leads to cost cutting on maintenance and/or training. That leads to increased accidents or incidents. Rose's results, as confirmed here, suggest a disconnect between airline profitability and safety.

This indicates a need for further research to determine a mechanism and a solution. The results of other research suggest possible alternatives.

Market-based pricing arrangements for landing rights that place a premium on peak demand periods has been cited as a place to start (Bailey and Kirstein, 1989: 157). Worsening airport congestion is one of the results of deregulation. User fees that reflected the opportunity costs of the peak period landing slots would help reduce this dangerous congestion. The extra revenue could be used to upgrade facilities to reduce the problem.

The experience with air taxi operations has shown that tightening training requirements and mandating higher experience levels for pilots can have a profound effect on safety. When stricter standards were accompanied by increased surveillance and inspection emphasis, safety levels of the air taxi services improved dramatically.

Deregulation did cause an increased workload in the FAA's air carrier inspection offices. This increased workload was not accompanied by increased staffing to match.

Whether stricter training requirements, congestion pricing at airports, or increased surveillance by the FAA are appropriate steps to take is not certain. Further research of this form where occurrences are separated by cause seems an appropriate place to start. In this way a mechanism for the deregulation safety connection might be ascertained.

Consumers have benefited from airline deregulation. For consumers to reap the full benefits of a competitive transportation system, policy makers need to consider the economic pressures of deregulation and their effect on the airlines. They also need to consider how the impacts of the expanding market for air travel affects the need for infrastructure and the need for safety surveillance and inspection.

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APPENDIX A

CONTROLLABLE - UNCONTROLLABLE

APPENDIX A

CONTROLLABLE - UNCONTROLLABLE

THE DATA

The separation of occurrences into those under the airlines control and those not under their control is central to this work. The data is taken from NTSB computer listings. The information included in the listings and the format of the listings changed in 1982 and again in 1983. The way the data was encoded also changed with the changes in formatting.

The listings are voluminous. The data fields available vary considerably for the three formats. Therefore, the three formats will be discussed separately.

Pre 1982

The first format, which was used up through 1981, consists of about 285 data fields. Approximately sixty-five per cent of these are coded entries. There were approximately 2500 different codes used for this process (NTSB, 1981: vi). For the purpose of determining whether the occurrence was or was not under the airlines' control, many of these fields were not required. Some of the encoded information did not directly pertain to the cause of the accident/incident. Some of the information had a direct bearing for some occurrences but not others. Fortunately most of these contained information that is repeated in the cause or remarks sections when pertinent.

The accident/incident listing formats are the same for all types of aircraft operations. Therefore, the raw data I received from the NTSB also included a large number of fields that applied to general aviation, helicopter operations, crop dusting, etc. that had no bearing on airline operations.

The first section is identifying information. It includes the identifier code, the date, time and place and the make and model of the aircraft. The second section contains general information. This includes additional information on the aircraft and the location, and information on the operator and the type of operations. It also includes the type of accident/incident and the operational phase.

The next section concerns weather, airport facilities, and data on the type of clearance and type of approach. The next section is planned routing. That is followed by data describing the accident site and pilot data. The pilot data includes ratings and certificates, experience, and medical information.

Causes and factors is the subject of the next section. This is the largest section. Up to ten cause/factors can be shown. There are approximately 1,200 codes available to describe the cause or factor. There is also a provision for entering a cause directly when no appropriate code exists.

The next section is a listing of injury codes. It is followed by two short narrative sections labeled remarks and cause. The cause section can be used for additional remarks if it is not needed to list the cause. This is the use most often made of this section.

The last few sections are detailed views of particular subjects. The first of these addresses engine failures and malfunctions and the crews' corrective actions. The next section covers weather and navigational aids in more detail. The next section provides a more detailed look at the pilots' flying experience with emphasis on recent experience.

The next section contains the results of alcohol and toxicology tests on the pilot. It also includes details on impact damage with an emphasis on survivability and the possibility of post-crash egress.

The next section covers fire detection and fire extinguishing equipment and certain other aircraft safety systems. The information shown includes the availability, use and in some cases the effectiveness of the equipment.

The next section is administrative data concerning the NTSB. The section following is germane to crop dusting and other aerial applications. The last two sections apply to collisions between aircraft, and ditching, respectively.

1982 and Post 1982

The changes in format in 1982 and again in 1983 did not change the nature of the data gathered. They did change the volume. From 285 fields the number rose to approximately 700. There were similar changes in the record length and the numbers of codes available.

The change in codes available was dramatic. Prior to 1982 it was possible to enter a code indicating that the pilot suffered from a psychological condition. Beginning in 1982, one could choose from a list of more than twenty "psychological conditions" ranging from diverted attention to company induced pressure to mental performance overload. Further it was then possible to apply these codes not just to the pilot but also to any other individual deemed relevant to the investigation.

Data Manipulations

The data was received on tape. It was in IBM-style fixed-length record files with multiple records per line and undetermined-length short records that are terminated by a new line. This required that a parsing routine be written and used on the data.

After the data had been parsed, it was necessary to sort the fields into the those required for the analysis and those that were extraneous to it.

The fields not used include those showing identifying characteristics of the aircrew members, their flying experience, and some medical information. Detailed accident location data and planned itineraries are not shown. Also left out are detailed breakouts of injury codes.

The information included is only data needed to make the determination of under the airline's control or not under the airline's control. These include causes, cause factors, person identification codes associated with the causes and factors, and a narrative description of the accident/incident.

Note that aircrew experience and medical data and detailed weather code fields are not included. The information in the cause/factor fields and the narrative are used to determine when this information is relevant.

DETERMINATIONS

The next step was to decode the data and make the appropriate determinations. Due to the huge number of possible codes and the relative paucity of occurrences, it was determined that the most expeditious way to decode was simply to reverse the coding process. This entailed simply looking up the code for each field in the record under scrutiny. Following are some examples of the determinations made for this study. The fields are decoded in the right-hand column.

The examples were chosen to illustrate the methods used. They include examples from each of the three formats. Note that the controllable/not controllable determination is a two step process. First a judgment is made as to the person or agency responsible for the occurrence. Then the determination of controllable or not is made, based on that person's relationship with the airline.

The responsible agents fell naturally into just a few groupings. The largest, of course, were pilot and maintenance. Passengers, manufacturers, and air traffic control (ATC) made up the largest groupings for those not under the airlines' control.*

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* A complete list of all responsible agents includes pilot with 339 occurrences; co-pilot, 20; flight engineer, 5; maintenance, 346; ground crew, 25; flight attendant, 71; and company, 12. Company includes both company policies and dispatchers. This is a total of 816 occurrences under the airlines' control. (Two occurrences had both pilot and maintenance as causes.)

Responsible agents not under the airlines' control include passengers, 53 occurrences; manufacturers, 40 (includes design and quality control); ATC, 37 (includes ground control); other aircraft, 28; no one, 27 (medical problems suffered by the crew in flight); National Weather Service, 17; hijackers, 13; airport/facilities, 13 (includes runway intrusions and ground vehicle collisions with aircraft); birds, 11; cargo, 5 (cargo that was mislabeled by shippers to circumvent FAR's); stowaway, 1; and contaminated fuel, 1. This a total of 246 not under the control of the airlines.

There were also 54 occurrences with the responsible party unknown. Foreign object damage where the source of the foreign object could not be determined caused two more. There were a total of 1,118 occurrences during the period of the study.

Maintenance

The first example has been extracted and decoded and is labeled Example 1. From the example we see that the nozzle retention vane failed due to metal fatigue. Further portions of the turbine assembly separated from the aircraft and caused foreign object damage to the wing. The determination is that maintenance is responsible for the occurrence.

This is a typical example. Systems or component failures are assumed to be a maintenance responsibility unless the NTSB specifically finds some other agency to be responsible. (See Example 2.) The reasoning here is that inspection and maintenance are company maintenance responsibilities. The decision to remove and replace a worn component or to wait until the next inspection cycle rest entirely with the company.

Example 2 shows how a failure might not be laid on maintenance. Here the cargo door failed and separated in flight causing an explosive decompression. The door's design is specifically listed as a cause. I made the determination that the responsible party was the manufacturer.

It is appropriate to digress here for a moment. There is a natural hierarchy when assessing responsibility for an aircraft accident. Before an aircraft is allowed to fly, the design is certified airworthy by the FAA. Maintenance personnel certify the aircraft ready. The pilot (or the pilot's representative) preflights the aircraft, affirming maintenance's judgment. Only then does the pilot accept responsibility and fly the airplane. It is only natural then to assume that if something goes wrong at this point that the pilot is responsible.

Maintenance would be held responsible only if the airplane was broken and that break was bad enough that the pilot could not be reasonably expected to rescue the situation. For an investigator to reach the conclusion that design was responsible was a novel idea.

Weather

The NTSB's purposes in assigning causes to these occurrences is different from that needed for this analysis. These differences show up most clearly with regard to occurrences involving adverse weather. In Example 3 the aircraft ran off the runway on landing roll-out. The weather conditions and a lack of snow removal operations are listed as the causes of the incident.

Weather does not cause accidents. Flying into adverse weather conditions that are beyond the capabilities of the aircraft or aircrew causes accidents. Rarely, misinformation concerning the nature or severity of the weather causes accidents.

In this case, while there was not as much information available as the crew apparently desired, there was no misinformation passed on. The crew did know that it was snowing hard enough to cause a complete white-out. They were told that the field had not been plowed since the snow started. And they did know that these conditions had prevailed for several minutes. Knowing all of this the crew decided to land at the scheduled destination anyway.

The aircraft in question had more than a hundred people on board. These people all had reason to expect that they would be able to make their business meetings, start their vacations or return to their families. These expectations can bring considerable pressure on the crew to complete the flight to the scheduled destination. It is exactly these kinds of issues that this study tries to address.

There is a group of occurrences classified as in-flight encounters with weather that need to be addressed. These involve turbulence. In Example 4 we see that the aircraft encountered turbulence and that several flight attendants and passengers were injured.

This is a recurring theme and several issues need to be addressed. First, turbulence is a common occurrence. It is so common that flights that encounter some turbulence are the rule rather than the exception. Second, those who travel with their seat belt securely fastened are not often injured by turbulence. Indeed, through this whole listing there is not one case of a person whose seat belt is securely fastened being injured by turbulence.

Given these observations, the turbulence related occurrences were sorted using the following criteria. If the seat belt sign was illuminated, the injured party was listed as the responsible party. In those cases where both passengers and flight attendants were injured, the flight attendant was listed as the responsible party. (The flight attendant is assumed to be more culpable than passengers.) In those cases where the seat belt sign is not on, the pilot is assumed responsible. In the few instances where the turbulence was clear air turbulence (CAT), and that turbulence was not forecast, the National Weather Service is listed as the responsible party. (See Example 5.)

In Example 5 the key phrase is "unforecast severe clear air turbulence." Note that the only warning of turbulence was a pilot report (pirep) that specifically denied the presence of severe turbulence. Another important factor is that the turbulence involved is clear air turbulence. Clear air turbulence is difficult (impossible) to foresee from the cockpit. While difficult to foresee from the cockpit, CAT is relatively easy to forecast. Therefore in this example the determination is that the National Weather Service (NWS) is responsible.

Medical

In Example 6 we have a case where the pilot suffers a heart attack. We have no indication there were earlier problems. The determination is no one is responsible. (At least given the requirement for a physical every six months there is nothing more that the company could be expected to do to avoid similar cases.)

Not all medical problems meet the same determination. See Example 7. Here the pilot did know he had a problem. He simply failed to meet his responsibilities. The company pays pilots to sit reserve and not fly just so there will be someone available to fly, if needed in a case like this. For this system to work those who aren't well enough to fly need to make that decision for themselves.

Unknown

Examples 8 and 9 show cases where a determination could not be made. Example 9, where the investigation results are not available, is the more common case.

Other Results

The other categories are straightforward. Hijackers are responsible for hijackings. Air traffic control is responsible for issuing inappropriate instructions. Passengers are responsible for their actions, such as being drunk or failing to follow instructions or starting fires in the lavatories.

The last category of occurrence is that caused by birds. Like all flyers, birds have a responsibility to see and avoid other flyers. This is especially true in the case of bird/aircraft collisions. The prognosis of these collisions is uniformly grave for birds; such collisions are rarely fatal to aircraft. Birds should be expected to see aircraft at greater distances than pilots can be expected to see birds. Lastly, evasive maneuvers sufficient to avoid collision are not likely to do more damage to the bird than the collision. This cannot always be said for the aircraft. Thus for all bird/aircraft collisions the bird is deemed to be the responsible party.

Controllable by the Airline

After the individual or entity responsible has been identified, the occurrences are sorted into controllable, uncontrollable or unknown. Those occurrences where the responsible individual is identified as a company employee are considered controllable. These categories include pilot, co-pilot, flight engineer, flight attendant, maintenance, company (usually taken to mean dispatchers or company policies), and ground crews.

Those listed as uncontrollable include hijacker, passenger, manufacturer, air traffic control, NWS, airport or airport facilities, other aircraft, cargo (cargo that was mislabeled and shipped contrary to FAA regulations), and stowaways. Also included is the category "no one." This was used most often to indicate a crewmember having an in-flight medical problem, while their medical certificate was complete and up-to-date.

The third category is that of unknown. It includes those occurrences where the investigation is complete, but no cause was found and those where information is incomplete or not available. These usually are those investigations under the jurisdiction of foreign governments. The unknown category also includes the two instances of foreign object damage where the source of the foreign object cannot be determined.

Example 1

Identification

Docket No	7401071 0001	
Date	73-01-20	
Aircraft Make	BOEING	
Aircraft Model	707	
Name Common Carrier	AA	
Operation Type	A	domestic passenger
Accident Type 1	U	engine failure or malfunction
Operational Phase	DO	climb to cruise
Accident Type 2	6	miscellaneous/other
Operational Phase	DO	climb to cruise

Injury Codes

Aircraft Fatal	0
Aircraft Serious	0
Aircraft Minor	0
Aircraft None	72
Aircraft Unknown	0
Aircraft Total	72
Other Aircraft Fatal	0
Other Aircraft Serious	0
Other Aircraft Minor	0
Other Aircraft None	0
Other Aircraft Unknown	0
Other Aircraft Total	0
Ground Fatal	0
Ground Serious	0
Ground Minor	0
Ground None	0
Ground Unknown	0
Ground Total	0

Causes and Factors

Cause Factor 1p	EN	engine
Cause 1	74	powerplants, turboprop/turbojet
	PF	retention, guide vane
Cause Factor 2p	MA	maintenance
Cause 2	88	miscellaneous acts or conditions
	36	fatigue, fracture (material)
Cause Factor 3p	MS	miscellaneous
Cause 3	84	miscellaneous
	D	foreign object damage (other than engine)
Cause Factor 4p	MA	maintenance
Cause 4	88	miscellaneous acts or conditions
	49	separation in flight

Remarks	FRETTING-3RD STAGE NOZZLE VANE RETAINING LUGS,NR
Cause	4 ENG.STRUCT WING DMG SEPD TURBINE ASSY

Example 2

Identification

Docket No	7305101 0004	
Date	72-06-12	
Aircraft Make	DOUGLAS	
Aircraft Model	DC-10	
Name Common Carrier	AA	
Operation Type	A	domestic passenger
Accident type 1	SO	airframe failure - in flight
Operational Phase	DO	climb to cruise

Injury Codes

Aircraft Fatal	0
Aircraft Serious	0
Aircraft Minor	11
Aircraft None	56
Aircraft Unknown	0
Aircraft Total	67
Other Aircraft Fatal	0
Other Aircraft Serious	0
Other Aircraft Minor	0
Other Aircraft None	0
Other Aircraft Unknown	0
Other Aircraft Total	0

Causes and Factors

Cause Factor 1p	AF	airframe
Cause 1	70	airframe
	BF	fuselage doors, door frames wheel well doors
Cause Factor 2p	MA	maintenance
Cause 2	88	miscellaneous acts and
	29	improperly secured
Cause Factor 3p	OP	other party
Cause 3	DESIG	design
Cause Factor 4p	MA	maintenance
Cause 4	88	miscellaneous acts and conditions
	94	overload failure
Cause Factor 5p	MA	maintenance
Cause 5	88	miscellaneous acts and conditions
	49	separation in flight
Cause Factor 6p	MA	maintenance
Cause 6	88	miscellaneous acts and conditions
	35	explosive decompression

Remarks Cause AFT BULK CARGO COMPT DOOR IMPROPERLY ENGAGED DURING FLT PREPARATION DUE DESIGN OF LATCH MECHANISM.

Identification

Control Number	CHI82IA117
Occurrence Date	04-09-82
Accident/Incident Code	I
Aircraft Manufacturer	BOEING
Aircraft Model and Series	727-200
Aircraft Owner	UNITED AIRLINES

Injury Codes

Aircraft None	108
Aircraft Total	108

Causes, Factors and Persons Responsible

Item	Code	Meaning
Control Number	CHI82IA117	
Group Counter	1	
Occurrence Number	1	
Occurrence Code	320	on ground collision with terrain
Phase Code	572	landing roll
A1 Sub-code	20000	weather condition
A1 Cause/Factor	C	
A1 Modifier Code	2230	whiteout
B1 Sub-code	24202	airport snow removal
B1 Cause/Factor	C	
B1 Modifier Code	3128	not performed
B1 Person Code	4124	ground personnel
Direct Code	55200	information unavailable
Direct Cause/Factor	F	
Direct Person	5350	airport personnel
A2 Sub-code	20000	weather condition
A2 Cause Factor	C	
A2 Modifier Code	2220	snow
A3 Sub-code	20000	weather condition
A3 Cause/Factor	C	
A3 Modifier Code	2218	obscuration

Narrative

AFTER ABORTING ONE APPROACH AND HOLDING FOR SEVERAL MINUTES, THE FLIGHT WAS CLEARED FOR THE ILS APPROACH RUNWAY 32 AT 0947 EST. WHILE THE FLIGHT WAS HOLDING, THE CREW HAD SEVERAL CONVERSATIONS WITH APPROACH CONTROL AND THE COMPANY REPRESENTATIVE REGARDING RUNWAY CONDITIONS AND BRAKING ACTION. ON 2 OCCASIONS, THE UNITED CREW REQUESTED, THROUGH THE TOWER, THAT AIRPORT PERSONNEL INSPECT THE RUNWAY. THE TOWER WAS UNABLE TO CONTACT ANYONE AND STATED THAT THE LAST FIELD CONDITION REPORT WAS TAKEN AT 0815 EST. THE CREW WAS ALSO INFORMED THAT THE FIELD WAS COMPLETELY WHITED OUT AND THERE HAD BEEN NO PLOWING SINCE THE SNOW STARTED. THE APPROACH AND TOUCHDOWN WERE NORMAL WITH THE LEFT MAIN GEAR TOUCHING DOWN ABOUT 20 FT INSIDE THE LEFT EDGE OF THE RUNWAY ABOUT 1200 FT FROM THE THRESHOLD. THE LEFT MAIN GEAR LEFT THE RUNWAY APPROXIMATELY 400 FT LATER AND TRAVELED AN ADDITIONAL 750 FT BEFORE THE RIGHT GEAR RAN OFF THE RUNWAY. PRIOR TO STOPPING, THE CREW WAS ABLE TO GET THE RIGHT MAIN AND NOSE GEAR BACK ON THE RUNWAY.

Example 4

NTSB No.	ANC87FA021
Accident Incident Code	1
Date	86-12-15
Day of Week	MO
Accident Occurrence Code	0
Aircraft Manufacturer	BOEING
Aircraft Series	727-222
Aircraft Owner	UNITED AIRLINES, INC.
Operator Same	1
Operator Name	
Operator DBA	
Operator Other	0
Operator Status	1

Injury Codes

Passenger Fatal	0
Passenger Serious	1
Passenger Minor	4
Passenger None	90

Causes, Factors and Persons Responsible

A1 Sub-code	20000	Weather condition
A1 Cause/Factor	C	cause
A1 Modifier Code	2224	turbulence

Narrative

ABOUT 10 MIN BEFORE ARRIVAL, THE ACFT SUDDENLY ENCOUNTERED TURBULENCE WHICH ONE OCCUPANT DESCRIBED AS A SINGLE TREMENDOUS JOLT. THE MISHAP OCCURRED WHILE THE ACFT WAS APRX 39 MILES EAST OF ANCHORAGE INTL ARPT AND WAS DESCENDING THRU 10,000 FT. THE SEAT BELT SIGN WAS ON & THE FLIGHT ATTENDANTS (F/A'S) WERE PREPARING THE CABIN FOR LANDING. ONE PASSENGER & ONE F/A WERE SERIOUSLY INJURED; THE OTHER THREE F/A'S & THREE OF THE PASSENGERS RECEIVED MINOR INJURIES. THERE WAS A SIGMET WHICH WARNED OF POSSIBLE TURBULENCE IN THE AREA.

Example 5

Identification

Control Number	DEN82IA098
Occurrence Date	05-27-82
Accident/Incident Code	I
Aircraft Manufacturer	DOUGLAS
Aircraft Model and Series	DC-8-61
Aircraft Owner	UNITED AIRLINES INC.

Injury Codes

Aircraft Fatal	0
Aircraft Serious	0
Aircraft Minor	17
Aircraft None	129
Aircraft Unknown	0
Aircraft Total	146

Causes, Factors and Persons Responsible

Item	Code	Meaning
Control Number	DEN82IA098	
Group Counter	1	
Occurrence Number	1	
Occurrence Code	240	in-flight encounter with weather
Phase Code	541	cruise - normal
A1 Sub-code	20000	weather condition
A1 Cause/Factor	C	
A1 Modifier Code	2205	downdraft
B1 Sub-code	24524	descent
B1 Cause/Factor		
B1 Modifier Code	3140	uncontrolled
B1 Person Code	4001	
A2 Sub-code	20000	weather conditions
A2 Cause Factor	C	
A2 Modifier Code	2225	turbulence, clear air

Narrative

THIS AIRCRAFT ENCOUNTERED UNFORECAST SEVERE CLEAR AIR TURBULANCE (CAT) WHILE IN CRUISE FLIGHT AT FL350 NEAR GOSHEN, IN. AS A RESULT OF THE ENCOUNTER, THE AIRCRAFT ENTERED AN UNCONTROLLED DESCENT WHICH WAS ARRESTED AT 31,500 FEET. A TOTAL OF SEVENTEEN PASSENGERS AND FIVE FLIGHT ATTENDANTS RECEIVED MINOR INJURIES. THE AIRCRAFT WAS INSPECTED AND FOUND AIRWORTHY. THE ONLY WARNING THAT THE CREW HAD AS TO THE POSSIBILITY OF CAT WAS A PIREP, PASSED ON BY THE CENTER CONTROLLER, THAT REPORTED MODERATE OR LESS TURBULANCE IN THE AREA. AFTER THE ENCOUNTER THE FLIGHT CONTINUED UNEVENTFULLY TO DENVER.

Example 6

Identification

Docket No.	8007024 0024	
Date	78-08-06	
Aircraft Make	BOEING	
Aircraft Model	707	
Carrier	TWA	
Operation Type	A	scheduled domestic passenger
Accident Type	6	miscellaneous/other
Operation Phase	B0	taxi to takeoff

Injury Codes

Aircraft Fatal	0
Aircraft Serious	1
Aircraft Minor	0
Aircraft None	58
Aircraft Unknown	0
Aircraft Total	59

Causes and Factors

Cause Factor 1p	P	pilot
Cause 1	64	pilot
	64	incapacitation
Cause Factor 2p	MA	miscellaneous acts, conditions
Cause 2	88	miscellaneous
	65	pilot suffered heart attack

Remarks MYOCARDIAL INFARCTION

Identification

NTSB No.	ATL86IA162
Date	86-06-08
Day of Week	SU
Accident Occurrence Code	OCC_CODE miscellaneous/other
	PHASE_CODE cruise normal
Aircraft Manufacturer	BOEING
Aircraft Series	727-225
Aircraft Owner	EASTERN AIRLINES

Injury Codes

Passenger Fatal	0
Passenger Serious	0
Passenger Minor	0
Passenger None	60

Causes, Factors and Persons Responsible

B1 Sub-code	planning decision
B1 Cause/Factor	pilot in command
B1 Modifier Code	improper
D2 Code	incapacitation (other organic problem)
D2 Person Code	pilot in command
B5 Sub-code	flight to alternate destination
B5 Modifier Code	performed

Narrative

DURING A SCHEDULED AIR CARRIER FLIGHT AT NORMAL CRUISING ALTITUDE, THE CAPTAIN PASSED OUT UPON RE-ENTERING THE COCKPIT AFTER EXCUSING HIMSELF TO GO TO THE LAVATORY. THE FLIGHT CREW DIVERTED TO AN ALTERNATE DESTINATION DUE TO THE MEDICAL EMERGENCY. A REVIEW OF THE CAPTAIN'S MEDICAL HISTORY REVEALED THAT CHRONIC LYMPHATIC LUKEMIA WAS DIAGNOSED IN 1981 AND WAS FIRST REPORTED TO THE FAA IN 1985. THE CAPTAIN HAD RECEIVED SPECIAL AUTHORIZATION FROM THE FAA TO HOLD A FIRST CLASS MEDICAL CERTIFICATE IN JULY OF 1985 AND RETURNED TO FLIGHT STATUS IN FEBRUARY OF 1986 AFTER A 7 MONTH PERIOD OF SICK LEAVE.

Example 8

Identification

Docket No.	6612211 0078	
Date	65-10-17	
Aircraft Make	Douglas	
Aircraft Model	DC-6	
Name Common Carrier	UAL	
Operation Type	A	domestic passenger service
Accident Type 1	F	gear retracted
Operational Phase	CO	takeoff run

Injury Codes

Aircraft Fatal	0
Aircraft Serious	0
Aircraft Minor	5
Aircraft None	11
Aircraft Unknown	0
Aircraft Total	16

Causes and Factors

Cause Factor 1p	MS	miscellaneous
Cause 1	84	miscellaneous
	I	undetermined

Remarks AT V1 SPD AS THE CAPT STARTED TO RAISE THE NOSEW
Cause HEEL IT RETRACTED.CAUSE OF RETRACTION NOT FOUND.

Identification

Docket No.	7503141 0041
Date	74-11-26
Aircraft Make	BOEING
Aircraft Model	747
Name Common Carrier	TWA
Operation Type	Scheduled International Passenger
Accident Type 1	6 miscellaneous/other
Operational Phase	A7 static, other

Injury Codes

Aircraft Fatal	0
Aircraft Serious	3
Aircraft Minor	47
Aircraft None	105
Aircraft Unknown	0
Aircraft Total	155

Causes and Factors

Remarks	ACFT AWAITING CLRNC.SPARKS & SMOKE FM COVE LT.F/
Cause	A INITIATED EVAAC.INVEST JURISDCTN GOVT OF ITALY.

APPENDIX B

DETERMINATIONS

APPENDIX B

DETERMINATIONS

A/L	Date	NTSB No.	Cause	Controllable
AAL	64/04/08	6607074 0004	pilot	yes
AAL	64/07/01	6607071 0038	pilot	yes
AAL	64/08/03	6810034 0015	maintenance	yes
AAL	64/09/30	6607074 0038	bird	no
AAL	64/10/15	6608054 0037	pilot	yes
AAL	64/10/21	6810034 0040	maintenance	yes
AAL	64/11/12	6607071 0053	maintenance	yes
AAL	64/12/06	6607074 0047	maintenance	yes
AAL	65/02/06	6602064 0014	pilot	yes
AAL	65/05/09	6611161 0053	pilot	yes
AAL	65/05/11	6904281 0018	manufacturer	no
AAL	65/06/13	6604054 0023	maintenance	yes
AAL	65/07/05	6605161 0054	pilot	yes
AAL	65/08/18	7008214 0044	maintenance	yes
AAL	65/10/02	6610064 0027	flight engineer	yes
AAL	65/10/17	6610064 0028	manufacturer	no
AAL	65/10/25	7202104 0037	maintenance	yes
AAL	65/11/08	7008211 0031	pilot	yes
AAL	66/01/30	6809271 0009	NWS	no
AAL	66/02/20	6803114 0051	unknown	unk
AAL	66/02/23	6707181 0045	pilot + maintenance	yes
AAL	66/04/10	6702204 0020	maintenance	yes
AAL	66/04/24	6807254 0021	pilot	yes
AAL	66/08/09	6706141 0026	passenger + WX	no
AAL	66/08/22	6803284 0056	maintenance	yes
AAL	66/09/15	6706061 0028	bird	no
AAL	66/09/30	6706141 0032	flight attendant + W X	yes
AAL	66/11/02	6707281 0056	pilot	yes
AAL	66/11/26	6902071 0067	copilot	yes
AAL	67/02/03	6808094 0019	maintenance	yes
AAL	67/03/11	6901101 0023	other a/c	no
AAL	67/08/08	6808094 0016	maintenance	yes
AAL	67/09/14	6808294 0027	maintenance	yes
AAL	67/11/12	6807104 0029	hijacker	no
AAL	68/02/29	6901101 0031	copilot	yes
AAL	68/03/07	6808014 0004	maintenance	yes
AAL	68/05/13	6809251 0017	pilot	yes
AAL	68/06/26	7410011 0019	maintenance	yes
AAL	68/09/06	6906191 0056	pilot	yes
AAL	68/09/23	6902031 0029	hijacker	no
AAL	68/11/19	6903071 0047	maintenance	yes
AAL	69/07/20	6909204 0020	maintenance	yes
AAL	70/02/25	7211091 0008	passenger + WX	no
AAL	70/02/26	7201241 0019	passenger	no
AAL	70/03/28	7206294 0025	no one	no
AAL	70/05/19	7204114 0029	no one	no
AAL	70/09/18	7204114 0045	maintenance	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
AAL	70/09/23	7011304 0035	maintenance	yes
AAL	70/10/20	7204114 0036	pilot	yes
AAL	70/11/08	7206294 0057	maintenance	yes
AAL	70/11/28	7204114 0054	maintenance	yes
AAL	70/12/04	7204114 0044	maintenance	yes
AAL	71/01/02	7112204 0006	NWS	no
AAL	71/01/09	7502121 0001	pilot	yes
AAL	71/01/14	7206294 0015	maintenance	yes
AAL	71/02/26	7210131 0031	maintenance	yes
AAL	71/03/08	7210174 0053	pilot	yes
AAL	71/03/29	7211141 0037	passenger + WX	no
AAL	71/03/31	7303224 0016	maintenance	yes
AAL	71/04/05	7202164 0004	maintenance	yes
AAL	71/07/21	7204214 0012	pilot	yes
AAL	71/07/21	7206274 0021	maintenance	yes
AAL	71/08/17	7209074 0045	maintenance	yes
AAL	71/10/20	7210024 0051	pilot	yes
AAL	72/06/10	7307181 0049	maintenance	yes
AAL	72/06/12	7305101 0004	manufacturer	no
AAL	72/07/14	7303144 0020	flight attendant	yes
AAL	72/08/19	7310184 0033	maintenance	yes
AAL	72/09/13	7304094 0035	maintenance	yes
AAL	72/10/30	7401074 0039	bird	no
AAL	72/12/14	7310184 0041	no one	no
AAL	73/01/20	7401071 0001	maintenance	yes
AAL	73/03/19	7408264 0007	pilot	yes
AAL	73/05/01	7408264 0010	maintenance	yes
AAL	73/05/07	7408264 0011	maintenance	yes
AAL	73/05/09	7311094 0019	pilot	yes
AAL	73/07/08	7408264 0013	maintenance	yes
AAL	73/09/04	7407181 0023	pilot	yes
AAL	73/09/05	7408264 0020	passenger	no
AAL	73/12/20	7406114 0031	no one	no
AAL	73/12/22	7409111 0036	hijacker	no
AAL	74/01/01	7407161 0011	pilot	yes
AAL	74/03/20	7506044 0018	ATC	no
AAL	74/05/14	7506044 0013	maintenance	yes
AAL	74/07/10	7602181 0028	maintenance	yes
AAL	74/10/03	7504244 0027	pilot + maintenance	yes
AAL	74/12/10	7812031 0045	pilot	yes
AAL	74/12/28	7512191 0044	pilot	yes
AAL	75/02/28	7606244 0001	flight attendant	yes
AAL	75/07/12	7606251 0033	passenger + WX	no
AAL	75/07/24	7606244 0007	maintenance	yes
AAL	75/08/23	7602041 0027	maintenance	yes
AAL	75/08/25	7707181 0032	maintenance	yes

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DETERMINATIONS
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A/L	Date	NTSB No.	Cause	Controllable
AAL	75/09/08	7606251 0026	manufacturer	no
AAL	75/09/17	7606244 0009	maintenance	yes
AAL	75/10/11	7606254 0015	maintenance	yes
AAL	75/11/26	7606241 0024	ATC	no
AAL	76/04/27	7708251 0005	pilot	yes
AAL	76/05/06	7702021 0006	pilot	yes
AAL	76/05/18	7610194 0009	passenger	no
AAL	76/08/08	7708251 0017	passenger + WX	no
AAL	76/09/19	7702021 0018	passenger	no
AAL	76/12/12	7709134 0018	maintenance	yes
AAL	77/01/25	7704261 0002	pilot	yes
AAL	77/03/04	7804281 0005	passenger + WX	no
AAL	77/04/05	7907064 0008	maintenance	yes
AAL	77/06/22	7806294 0010	maintenance	yes
AAL	77/07/28	7804284 0007	maintenance	yes
AAL	78/05/21	7901181 0011	maintenance	yes
AAL	78/08/08	8005231 0004	flight attendant	yes
AAL	78/09/20	8007021 0016	pilot	yes
AAL	78/10/04	7908271 0022	company	yes
AAL	78/11/07	7908274 0021	other a/c	no
AAL	79/04/10	8102094 0008	maintenance	yes
AAL	79/04/19	8102091 0032	pilot	yes
AAL	79/05/25	8011181 0028	maintenance	yes
AAL	79/08/29	8102094 0015	pilot	yes
AAL	79/09/18	8102091 0029	unknown	unk
AAL	80/10/17	8109231 0012	unknown	unk
AAL	81/09/07	8212141 0013	company	yes
AAL	81/10/13	8212141 0017	flight attendant	yes
AAL	81/12/18	8212224 0007	maintenance	yes
AAL	82/11/22	FTW83IA044 I	pilot	yes
AAL	82/12/26	FTW83IA086 I	pilot	yes
AAL	82/12/30	FTW83IA072 I	flight attendant	yes
AAL	83/01/13	CHI83IA097 2	copilot	yes
AAL	83/09/07	CHI83IA418 2	maintenance	yes
AAL	83/09/23	FTW83IA438 2	unknown	unk
AAL	83/10/05	FTW84IA007 2	unknown	unk
AAL	83/10/12	NYC84IA007 2	pilot	yes
AAL	83/11/08	CHI84IA041 2	maintenance	yes
AAL	83/12/07	NYC84IA048 2	maintenance	yes
AAL	83/12/29	LAX84IA119 2	maintenance	yes
AAL	84/02/17	LAX84IA195 2	maintenance	yes
AAL	84/03/10	FTW84IA160 2	maintenance	yes
AAL	84/07/03	DEN84IA209 2	pilot	yes
AAL	84/10/17	LAX85IA023 2	maintenance	yes
AAL	84/12/12	NYC85IA043 2	maintenance	yes
AAL	85/03/24	CHI85IA149 2	copilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
AAL	85/03/29	FTW85IA168 2	pilot	yes
AAL	85/04/16	LAX85IA206 2	manufacturer	no
AAL	85/04/23	CHI85FA174 1	pilot	yes
AAL	85/05/27	CHI85IA212 2	maintenance	yes
AAL	85/05/28	NYC85FA138 1	maintenance	yes
AAL	85/06/23	CHI85FA249A1	copilot	yes
AAL	85/06/27	DCA85AA027 1	airport/facilities	no
AAL	85/08/07	CHI85IA339 2	maintenance	yes
AAL	85/09/03	FTW85IA341 2	maintenance	yes
AAL	85/10/24	LAX86IA021 2	ground crew	yes
AAL	85/11/07	MKC86LA025 1	bird	no
AAL	86/01/02	CHI86MA056 2	copilot	yes
AAL	86/02/08	DCA86IA017 2	pilot	yes
AAL	86/03/02	CHI86IA099 2	no one	no
AAL	86/03/12	ATL86LA090 1	maintenance	yes
AAL	86/05/07	FTW86IA078 2	pilot	yes
AAL	86/05/17	CHI86MA142B2	ATC	no
AAL	87/01/06	MIA87IA068 2	maintenance	yes
AAL	87/03/08	NYC87IA105 2	manufacturer	no
AAL	87/03/23	CHI87IA100 2	manufacturer	no
AAL	87/03/25	CHI87MA101 1	maintenance	yes
AAL	87/03/26	SEA87IA068 2	maintenance	yes
AAL	87/05/29	CHI87IA135 2	ATC	no
AAL	87/06/06	LAX87IA230 2	maintenance	yes
AAL	87/08/02	CHI87IA183A2	other a/c	no
AAL	87/08/11	LAX87IA304 2	ATC	no
AAL	87/09/02	MIA87IA237 2	maintenance	yes
AAL	87/10/09	LAX88IA009 2	other a/c	no
AAL	87/11/21	FTW88IA029 2	no one	no
AAL	87/12/26	MIA88LA075A1	pilot	yes
AAL	87/12/26	MIA88LA075B1	other a/c	no
AAL	88/01/10	FTW88LA050 1	flight attendant	yes
AAL	88/01/19	CHI88FA048 1	pilot	yes
AAL	88/01/27	NYC88LA074 1	flight attendant	yes
AAL	88/02/03	DCA88MZ002 2	cargo	no
AAL	88/02/10	CHI88IA061 2	airport/facilities	no
AAL	88/03/24	CHI88IA081 2	pilot	yes
AAL	88/05/09	FTW88IA097 2	maintenance	yes
AAL	88/05/21	FTW88NA106 1	manufacturer	no
AAL	88/05/23	MIA88IA176B2	ATC	no
AAL	88/07/14	CHI88IA165 2	copilot	yes
AAL	88/09/21	FTW88IA165 2	manufacturer	no
AAL	88/10/17	MIA89IA012 2	pilot	yes
AAL	88/10/24	MIA89IA016 2	maintenance	yes
AAL	88/11/27	MIA89IA043 2	maintenance	yes
AAL	88/12/30	NYC89IA063A2	ATC	no

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A/L	Date	NTSB No.	Cause	Controllable
CAL	65/05/03	6601041 0052	manufacturer	no
CAL	65/07/01	6704211 0019	pilot	yes
CAL	65/08/17	6702151 0044	other a/c	no
CAL	65/10/17	6610061 0064	company	yes
CAL	66/03/24	6706061 0020	pilot	yes
CAL	66/05/14	6702204 0023	manufacturer	no
CAL	66/11/04	6706144 0038	maintenance	yes
CAL	67/08/18	6808291 0054	flight attendant	yes
CAL	68/11/19	6902014 0016	passenger	no
CAL	69/08/26	7001231 0032	NWS	no
CAL	69/12/21	7006061 0061	flight attendant	yes
CAL	70/11/20	7201241 0038	flight attendant + W X	yes
CAL	70/12/16	7410011 0047	manufacturer	no
CAL	71/04/26	7207314 0029	pilot	yes
CAL	71/06/08	7210131 0033	passenger + WX	no
CAL	71/08/04	7211291 0014	pilot	yes
CAL	72/01/14	7303154 0025	no one	no
CAL	72/01/21	7310184 0024	pilot	yes
CAL	72/10/19	7409204 0037	passenger + WX	no
CAL	75/07/25	7606244 0014	maintenance	yes
CAL	75/08/07	7606281 0012	pilot	yes
CAL	76/02/16	7608241 0012	maintenance	yes
CAL	76/05/25	7708164 0012	pilot	yes
CAL	76/05/27	7708251 0010	pilot	yes
CAL	77/06/03	7808071 0022	pilot	yes
CAL	78/03/01	7908211 0001	pilot	yes
CAL	79/08/07	8102091 0021	maintenance	yes
CAL	80/11/21	8109231 0002	pilot	yes
CAL	81/06/27	8201144 0017	copilot	yes
CAL	81/11/05	8212144 0023	pilot	yes
CAL	82/04/18	FTW82DA139 A	maintenance	yes
CAL	82/11/18	DEN83FA021 A	maintenance	yes
CAL	83/05/20	MKC83FA112 1	pilot	yes
CAL	83/06/04	LAX83LA262 1	maintenance	yes
CAL	83/07/02	LAX83IA316 2	company	yes
CAL	83/11/09	DEN84IA023 2	pilot	yes
CAL	83/12/18	MKC84IA040 2	maintenance	yes
CAL	83/12/28	LAX84AA132 1	pilot	yes
CAL	84/03/20	MKC84IA108 2	airport/facilities	no
CAL	84/03/22	DEN84IA116 2	pilot	yes
CAL	85/01/17	DEN85IA065 2	airport/facilities	no
CAL	86/02/20	DEN86FA080 1	copilot	yes
CAL	86/05/25	FTW86IA093 2	foreign object damage	unk
CAL	86/08/05	MIA86LA229 1	passenger + WX	no
CAL	86/11/07	LAX87MA044 1	maintenance	yes
CAL	87/01/03	NYC87IA087 2	maintenance	yes

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A/L	Date	NTSB No.	Cause	Controllable
CAL	87/02/25	LAX87MA125A1	ATC	no
CAL	87/08/02	CHI87IA183B2	pilot	yes
CAL	87/08/03	DEN87IA207 2	maintenance	yes
CAL	87/11/01	MIA88IA055A2	ATC	no
CAL	87/11/01	MIA88IA055B2	ATC	no
CAL	87/11/15	DCA88MA004 1	pilot	yes
CAL	87/12/03	FTW88IA037 2	manufacturer	no
CAL	87/12/27	DEN88IA043 2	pilot	yes
CAL	88/03/10	ATL88IA108A2	ATC	no
CAL	88/03/10	ATL88IA108B2	ATC	no
CAL	88/03/18	NYC88IA109A2	ATC	no
CAL	88/04/03	MIA88FA138 1	pilot	yes
CAL	88/04/17	ATL88IA147 2	manufacturer	no
CAL	88/07/06	CHI88IA159 2	maintenance	yes
DEL	64/03/26	6607071 0030	pilot	yes
DEL	64/05/05	6607074 0007	pilot	yes
DEL	64/06/10	6607074 0052	pilot	yes
DEL	64/08/26	6607074 0022	pilot	yes
DEL	64/11/24	6607071 0054	copilot	yes
DEL	65/11/18	6610064 0034	maintenance	yes
DEL	66/02/27	6706141 0018	copilot	yes
DEL	66/03/03	7003261 0011	pilot	yes
DEL	66/03/04	6710171 0012	company	yes
DEL	66/08/10	6706144 0029	maintenance	yes
DEL	66/09/22	6706061 0029	pilot	yes
DEL	66/10/22	6807251 0055	pilot	yes
DEL	66/11/18	6706144 0045	maintenance	yes
DEL	67/03/07	6710121 0014	pilot	yes
DEL	67/06/17	6807104 0038	maintenance	yes
DEL	67/06/24	6904171 0027	maintenance	yes
DEL	67/09/16	6807251 0052	other a/c	no
DEL	68/03/20	6902191 0015	pilot	yes
DEL	68/06/30	6906191 0054	maintenance	yes
DEL	69/01/31	7001231 0028	manufacturer	no
DEL	69/03/07	7004014 0037	maintenance	yes
DEL	69/03/16	7011161 0012	flight attendant	yes
DEL	69/05/08	7001231 0035	pilot	yes
DEL	69/06/10	7002041 0040	pilot	yes
DEL	69/07/22	7001231 0030	pilot	yes
DEL	69/08/02	7004011 0047	flight attendant	yes
DEL	69/09/04	7001231 0034	pilot	yes
DEL	69/09/17	7005271 0056	maintenance	yes
DEL	69/10/16	7002044 0029	maintenance	yes
DEL	70/05/18	7211091 0039	pilot	yes
DEL	70/09/08	7410011 0016	pilot	yes
DEL	70/12/27	7709131 0043	flight attendant	yes

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A/L	Date	NTSB No.	Cause	Controllable
DEL	71/01/11	7206151 0004	pilot	yes
DEL	71/05/18	7410011 0012	flight attendant	yes
DEL	71/08/05	7205121 0023	pilot	yes
DEL	71/08/18	7209071 0036	bird	no
DEL	71/10/09	7204101 0022	ground crew	yes
DEL	71/12/26	7206094 0020	stow-away	no
DEL	72/02/26	7401281 0019	passenger + WX	no
DEL	72/03/18	7312074 0045	maintenance	yes
DEL	72/03/19	7304231 0011	maintenance	yes
DEL	72/03/28	7401141 0012	pilot	yes
DEL	72/05/06	7310184 0028	pilot	yes
DEL	72/07/22	7401141 0032	pilot	yes
DEL	72/09/17	7303144 0023	pilot	yes
DEL	72/09/28	7410011 0035	pilot	yes
DEL	72/09/30	7304231 0031	pilot	yes
DEL	72/12/20	7310181 0017	ATC	no
DEL	73/01/08	7408264 0003	maintenance	yes
DEL	73/02/28	7401071 0002	flight attendant	yes
DEL	73/04/01	7304101 0004	flight attendant	yes
DEL	73/07/31	7311084 0022	pilot	yes
DEL	73/07/31	7505141 0011	pilot	yes
DEL	73/08/20	7401071 0021	flight attendant	yes
DEL	73/11/27	7502261 0028	pilot	yes
DEL	73/12/21	7407181 0031	NWS	no
DEL	74/01/03	7305104 0003	pilot	yes
DEL	74/02/15	7305101 0003	flight attendant	yes
DEL	74/02/21	7409111 0015	pilot	yes
DEL	74/04/05	7506044 0019	cargo	no
DEL	74/04/06	7506044 0020	cargo	no
DEL	74/07/03	7410151 0023	pilot	yes
DEL	74/07/27	7410151 0022	flight attendant	yes
DEL	74/08/03	7506044 0014	cargo	no
DEL	74/11/06	7501241 0034	pilot	yes
DEL	74/11/25	7602181 0038	maintenance	yes
DEL	75/05/06	7508114 0004	pilot	yes
DEL	75/08/03	7602054 0012	pilot	yes
DEL	75/08/08	7603051 0015	NWS	no
DEL	75/08/16	7603051 0029	pilot	yes
DEL	75/09/22	7604131 0028	ATC	no
DEL	75/09/29	7606244 0018	maintenance	yes
DEL	75/11/07	7606244 0025	pilot	yes
DEL	75/12/22	7612101 0045	pilot	yes
DEL	76/01/25	7709134 0005	maintenance	yes
DEL	76/02/22	7704071 0004	flight attendant	yes
DEL	76/03/03	7612101 0007	passenger + WX	no
DEL	76/03/16	7709134 0008	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
DEL	76/05/27	7702021 0013	passenger + WX	no
DEL	76/12/27	7709134 0017	maintenance	yes
DEL	77/02/21	7807201 0003	pilot	yes
DEL	77/04/13	7804284 0004	maintenance	yes
DEL	77/08/05	7804281 0014	flight attendant	yes
DEL	78/03/28	8005231 0002	pilot	yes
DEL	78/06/11	8101141 0009	pilot	yes
DEL	78/08/08	7810144 0007	maintenance	yes
DEL	78/08/12	7908274 0019	unknown	unk
DEL	78/08/31	7908274 0025	company	yes
DEL	78/09/07	7812181 0014	other a/c	no
DEL	79/02/15	8102091 0012	ATC	no
DEL	79/06/24	8103171 0014	flight attendant	yes
DEL	79/07/15	8102091 0015	hijacker	no
DEL	79/11/25	8104084 0023	no one	no
DEL	80/05/22	8106194 0007	manufacturer	no
DEL	80/07/15	8012161 0004	flight attendant	yes
DEL	80/09/12	8106191 0010	flight attendant	yes
DEL	81/04/17	8212144 0005	maintenance	yes
DEL	81/05/18	8212221 0022	flight attendant	yes
DEL	81/05/29	8109084 0003	pilot	yes
DEL	81/08/10	8209224 0020	manufacturer	no
DEL	83/11/26	CHI84IA052B2	other a/c	no
DEL	84/06/03	MIA84IA174 2	unknown	unk
DEL	84/07/16	CHI84IA301 2	maintenance	yes
DEL	84/10/19	ATL85LA014 1	flight attendant	yes
DEL	85/04/16	BFO85IA036 2	pilot	yes
DEL	85/05/11	FTW85IA221 2	maintenance	yes
DEL	85/08/02	DCA85AA031 1	pilot	yes
DEL	85/09/08	MIA85IA246 2	maintenance	yes
DEL	85/10/24	NYC86IA019B2	pilot	yes
DEL	85/10/25	FTW86IA020 2	pilot	yes
DEL	85/12/28	MIA86MA048 2	maintenance	yes
DEL	86/01/09	ATL86IA054 2	maintenance	yes
DEL	86/11/13	DCA87MA012 1	manufacturer	no
DEL	87/06/18	ATL87IA179A2	copilot	yes
DEL	87/07/07	ATL87IA201 2	pilot	yes
DEL	87/07/12	NYC87IA202 2	pilot	yes
DEL	87/08/25	ATL87FA240 1	pilot	yes
DEL	87/11/10	ATL88LA034 1	flight attendant	yes
DEL	87/12/01	LAX88IA064 2	pilot	yes
DEL	88/01/25	ATL88LA084 1	flight attendant	yes
DEL	88/03/09	ATL88IA107 2	airport/facilities	no
DEL	88/03/20	SEA88IA065 2	maintenance	yes
DEL	88/03/22	NYC88IA112 2	no one	no
DEL	88/08/01	MIA88IA240 2	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
DEL	88/08/05	ATL88IA226B2	other a/c	no
DEL	88/08/23	LAX88IA311 2	no one	no
DEL	88/08/26	ATL88FA239 1	pilot	yes
DEL	88/08/31	DCA88MA072 1	pilot	yes
DEL	88/12/19	ATL89IA057 2	copilot	yes
EAL	64/01/22	6607074 0001	maintenance	yes
EAL	64/02/13	6607074 0025	maintenance	yes
EAL	64/02/17	6608054 0073	maintenance	yes
EAL	64/02/25	7104071 0006	pilot	yes
EAL	64/05/27	6810034 0075	maintenance	yes
EAL	64/05/30	6607074 0028	maintenance	yes
EAL	64/06/08	6607074 0010	maintenance	yes
EAL	64/06/18	6607074 0012	pilot	yes
EAL	64/07/01	6607074 0036	pilot	yes
EAL	64/07/15	6607071 0049	flight attendant	yes
EAL	64/07/17	6704251 0040	pilot	yes
EAL	64/07/20	6607071 0056	copilot	yes
EAL	64/07/24	6607071 0068	passenger + WX	no
EAL	64/09/23	6607071 0045	ground crew	yes
EAL	64/10/15	6607074 0043	maintenance	yes
EAL	64/10/18	6607074 0068	pilot	yes
EAL	64/10/30	6602194 0041	ground crew	yes
EAL	64/12/29	6607074 0066	maintenance	yes
EAL	65/01/08	6804221 0034	maintenance	yes
EAL	65/01/12	6602064 0002	maintenance	yes
EAL	65/01/17	6607074 0015	maintenance	yes
EAL	65/02/08	7110181 0001	pilot	yes
EAL	65/03/05	6611161 0035	copilot	yes
EAL	65/04/19	6601041 0074	flight attendant	yes
EAL	65/04/26	6810024 0036	maintenance	yes
EAL	65/07/12	6607074 0025	maintenance	yes
EAL	65/07/16	6610064 0020	manufacturer	no
EAL	65/09/28	6605164 0031	pilot	yes
EAL	65/10/16	6702151 0063	pilot	yes
EAL	65/11/05	6610064 0032	maintenance	yes
EAL	65/12/04	7202101 0033	pilot	yes
EAL	66/01/17	6609064 0004	maintenance	yes
EAL	66/01/23	6611021 0003	pilot	yes
EAL	66/03/05	6707181 0049	pilot	yes
EAL	66/03/15	6810024 0011	pilot	yes
EAL	66/04/16	6610064 0012	passenger	no
EAL	66/04/17	6611084 0016	maintenance	yes
EAL	66/05/06	6611034 0018	no one	no
EAL	66/05/20	6610064 0014	pilot	yes
EAL	66/05/26	6703214 0025	pilot	yes
EAL	66/06/18	6706061 0040	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
EAL	66/09/28	6706141 0031	copilot	yes
EAL	66/10/26	6706064 0044	maintenance	yes
EAL	67/03/14	6709261 0015	ground crew	yes
EAL	67/03/14	6808094 0014	pilot	yes
EAL	67/03/22	6808094 0007	maintenance	yes
EAL	67/04/08	6808094 0009	maintenance	yes
EAL	67/05/15	6804081 0034	passenger + WX	no
EAL	67/06/02	6808094 0024	maintenance	yes
EAL	67/06/09	6807101 0057	ATC	no
EAL	67/08/02	6808294 0036	maintenance	yes
EAL	67/08/18	6808094 0023	pilot	yes
EAL	67/08/25	6807251 0049	pilot	yes
EAL	67/08/30	6804101 0039	pilot	yes
EAL	67/10/01	6804101 0041	passenger + WX	no
EAL	67/10/05	6808294 0037	maintenance	yes
EAL	67/12/12	6807104 0034	maintenance	yes
EAL	68/01/13	6808014 0002	pilot	yes
EAL	68/01/25	7004011 0068	NWS	no
EAL	68/03/02	6903181 0006	pilot	yes
EAL	68/03/23	6809254 0008	maintenance	yes
EAL	68/03/23	6903191 0048	maintenance	yes
EAL	68/06/12	6902144 0023	flight attendant	yes
EAL	68/06/12	6911241 0069	pilot	yes
EAL	68/12/23	6904174 0027	pilot	yes
EAL	69/01/13	6906204 0005	pilot	yes
EAL	69/02/27	6907314 0006	pilot	yes
EAL	69/04/27	6912041 0018	pilot	yes
EAL	69/04/27	6912191 0019	flight attendant	yes
EAL	69/05/01	7003264 0033	maintenance	yes
EAL	69/05/05	7005284 0038	maintenance	yes
EAL	69/05/08	6909264 0017	pilot	yes
EAL	69/05/11	7003264 0034	maintenance	yes
EAL	69/06/09	7004144 0039	maintenance	yes
EAL	69/08/02	7001231 0031	passenger + WX	no
EAL	69/09/26	6912191 0024	airport/facilities	no
EAL	69/11/28	7011271 0054	maintenance	yes
EAL	69/12/13	7006061 0055	passenger	no
EAL	70/03/10	7206294 0014	pilot	yes
EAL	70/03/17	7204114 0015	hijacker	no
EAL	70/03/19	7204114 0006	no one	no
EAL	70/06/03	7211091 0015	maintenance	yes
EAL	70/06/16	7206294 0063	maintenance	yes
EAL	70/07/29	7204114 0028	pilot	yes
EAL	70/10/22	7204114 0048	no one	no
EAL	70/12/29	7204114 0061	pilot	yes
EAL	71/04/12	7207314 0028	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
EAL	71/04/13	7207314 0031	no one	no
EAL	71/05/14	7202161 0009	NWS	no
EAL	71/05/21	7207314 0030	manufacturer	no
EAL	71/06/01	7208144 0035	maintenance	yes
EAL	71/11/08	7209124 0050	maintenance	yes
EAL	71/12/04	7301221 0021	ATC	no
EAL	71/12/21	7303224 0018	pilot	yes
EAL	71/12/23	7210111 0045	pilot	yes
EAL	72/02/19	8012151 0008	maintenance	yes
EAL	72/04/21	7303141 0029	airport/facilities	no
EAL	72/05/10	7304231 0018	maintenance	yes
EAL	72/05/18	7401141 0002	pilot	yes
EAL	72/06/17	7311084 0014	ground crew	yes
EAL	72/07/01	7303024 0018	maintenance	yes
EAL	72/08/12	7310184 0036	pilot	yes
EAL	72/11/08	7410011 0040	maintenance	yes
EAL	72/12/28	7306181 0045	maintenance	yes
EAL	72/12/29	7308171 0016	pilot	yes
EAL	73/01/19	7408024 0001	pilot	yes
EAL	73/02/09	7408024 0006	pilot	yes
EAL	73/04/10	7310254 0012	pilot	yes
EAL	73/05/31	7308234 0014	maintenance	yes
EAL	73/08/25	7407181 0032	passenger + WX	no
EAL	73/09/13	7411184 0034	pilot	yes
EAL	73/11/27	7502261 0029	pilot	yes
EAL	73/12/17	7407181 0035	pilot	yes
EAL	74/03/21	7408291 0017	passenger + WX	no
EAL	74/07/08	7411084 0017	manufacturer	no
EAL	74/07/08	7411204 0016	manufacturer	no
EAL	74/09/01	7709131 0010	flight attendant	yes
EAL	74/09/11	7508011 0020	pilot	yes
EAL	74/11/21	7601301 0037	other a/c	no
EAL	74/12/01	7602181 0036	flight attendant	yes
EAL	74/12/14	7506044 0022	pilot	yes
EAL	74/12/19	7503264 0024	maintenance	yes
EAL	75/01/17	7606244 0003	manufacturer	no
EAL	75/02/04	7603051 0002	maintenance	yes
EAL	75/04/26	7603051 0010	flight attendant	yes
EAL	75/06/18	7606244 0021	maintenance	yes
EAL	75/06/24	7604301 0006	pilot	yes
EAL	75/09/02	7606244 0022	pilot	yes
EAL	75/11/12	7605111 0022	pilot	yes
EAL	75/12/31	7605204 0031	pilot	yes
EAL	76/01/20	7709134 0002	hijacker	no
EAL	76/02/23	7709134 0004	other a/c	no
EAL	76/08/02	7708161 0021	pilot	yes

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DETERMINATIONS
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A/L	Date	NTSB No.	Cause	Controllable
EAL	76/10/25	7709144 0019	airport/facilities	no
EAL	76/11/02	7709134 0015	maintenance	yes
EAL	76/12/07	7709134 0014	pilot	yes
EAL	77/03/12	7803201 0020	passenger + WX	no
EAL	77/05/25	7804284 0014	maintenance	yes
EAL	77/09/21	7804281 0001	passenger + WX	no
EAL	77/10/09	7804284 0022	maintenance	yes
EAL	77/12/31	7903164 0028	maintenance	yes
EAL	77/12/31	8001314 0025	maintenance	yes
EAL	78/01/18	7908274 0003	maintenance	yes
EAL	78/02/10	7908274 0001	maintenance	yes
EAL	78/03/09	7809081 0008	passenger	no
EAL	78/04/19	7908271 0012	flight attendant	yes
EAL	78/12/06	8008061 0020	passenger + WX	no
EAL	79/01/12	8102094 0002	maintenance	yes
EAL	79/03/22	7909104 0001	pilot	yes
EAL	80/04/04	8012161 0003	flight attendant	yes
EAL	80/04/11	8106194 0002	maintenance	yes
EAL	80/09/10	8106194 0015	unknown	unk
EAL	81/01/31	8212141 0011	maintenance	yes
EAL	81/02/06	8212141 0007	maintenance	yes
EAL	81/03/29	8212144 0009	pilot	yes
EAL	81/04/08	8212144 0026	maintenance	yes
EAL	81/06/02	8312234 0031	pilot	yes
EAL	81/09/11	8212144 0027	no one	no
EAL	81/09/22	8209221 0026	manufacturer	no
EAL	81/10/12	8212141 0021	pilot	yes
EAL	81/11/05	8212224 0025	ground crew	yes
EAL	82/04/20	MIA82IA102 I	maintenance	yes
EAL	82/10/03	FTW83IA005 2	pilot	yes
EAL	82/12/06	MIA83IA043 I	maintenance	yes
EAL	83/02/07	DCA83IA016 2	pilot	yes
EAL	83/02/15	MIA83IA075 2	unknown	unk
EAL	83/03/18	LAX83IA149B2	other a/c	no
EAL	83/05/05	MIA83AA136 2	maintenance	yes
EAL	83/06/25	MIA83IA165 2	unknown	unk
EAL	83/11/06	MIA84IA025 2	maintenance	yes
EAL	83/11/11	DCA84AA006 1	maintenance	yes
EAL	84/01/20	MIA84IA063 2	maintenance	yes
EAL	84/01/21	MIA84IA064 2	maintenance	yes
EAL	84/02/16	ATL84IA104 2	maintenance	yes
EAL	84/05/26	DEN84IA163 2	pilot	yes
EAL	84/07/16	DCA84IA030A2	ATC	no
EAL	84/07/25	ATL84LA235 1	passenger + WX	no
EAL	84/08/25	MIA84IA242 2	unknown	unk
EAL	85/01/31	CHI85IA101 2	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
EAL	85/05/28	MIA85FA178 1	pilot	yes
EAL	85/08/11	BFO85IA065 2	passenger	no
EAL	85/08/29	ATL85IA263 2	pilot	yes
EAL	85/10/19	MIA86MA013 2	maintenance	yes
EAL	85/12/30	ATL86IA051 2	manufacturer	no
EAL	86/01/17	DCA86AA014 1	maintenance	yes
EAL	86/02/05	MIA86IA072 2	maintenance	yes
EAL	86/02/15	NYC86FA076 1	pilot	yes
EAL	86/03/13	ATL86IA093 2	pilot	yes
EAL	86/03/16	MIA86IA098 2	maintenance	yes
EAL	86/06/08	ATL86IA162 2	pilot	yes
EAL	86/07/13	MIA86FA208 1	passenger + WX	no
EAL	86/07/19	MIA86IA213 2	manufacturer	no
EAL	86/09/17	CHI86IA225 2	pilot	yes
EAL	86/09/25	DCA86IA001 2	pilot	yes
EAL	87/03/10	NYC87IA106 2	airport/facilities	no
EAL	87/03/29	CHI87FA106 1	flight attendant	yes
EAL	87/06/26	DCA87IA037 2	maintenance	yes
EAL	87/07/11	MIA87IA204 2	pilot	yes
EAL	87/09/15	MIA87FA248 1	pilot	yes
EAL	87/09/28	NYC87FA264 1	pilot	yes
EAL	87/09/29	MIA87IA264A2	ATC	no
EAL	87/11/15	ATL88IA037 2	maintenance	yes
EAL	87/12/15	MKC88FA028B1	ATC	no
EAL	87/12/27	MIA88NA070 1	pilot	yes
EAL	88/04/11	ATL88IA139 2	maintenance	yes
EAL	88/08/05	ATL88IA226A2	ground crew	yes
EAL	88/12/26	DCA89IA016 2	maintenance	yes
NWA	64/02/24	6603011 0020	maintenance	yes
NWA	64/03/09	6607074 0050	flight attendant	yes
NWA	64/03/17	6607071 0022	flight attendant	yes
NWA	64/04/24	6607071 0055	maintenance	yes
NWA	64/09/07	6607071 0069	maintenance	yes
NWA	64/12/21	6607074 0044	bird	no
NWA	65/01/23	6803011 0050	NWS	no
NWA	65/05/29	6610064 0016	maintenance	yes
NWA	65/07/31	6602044 0021	copilot	yes
NWA	65/08/11	6605074 0024	other a/c	no
NWA	66/05/05	6611084 0017	unknown	unk
NWA	67/02/25	6808094 0005	pilot	yes
NWA	68/03/03	7410011 0004	ground crew	yes
NWA	68/07/20	6904251 0049	NWS	no
NWA	68/07/23	6909121 0059	flight attendant	yes
NWA	68/09/04	6902244 0012	pilot	yes
NWA	68/10/05	6901051 0026	passenger	no
NWA	68/11/19	7410011 0051	ground crew	yes

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A/L	Date	NTSB No.	Cause	Controllable
NWA	70/08/22	7204114 0039	no one	no
NWA	70/12/18	7112164 0081	pilot	yes
NWA	71/03/13	7207314 0025	maintenance	yes
NWA	71/05/13	7303224 0005	maintenance	yes
NWA	71/05/20	7203234 0009	maintenance	yes
NWA	71/05/25	7207314 0032	maintenance	yes
NWA	71/06/20	7210131 0039	unknown	unk
NWA	71/09/02	7303304 0041	maintenance	yes
NWA	71/10/09	7209074 0043	pilot	yes
NWA	72/04/12	7304231 0007	NWS	no
NWA	72/04/26	7202094 0002	pilot	yes
NWA	72/05/06	7310181 0023	pilot	yes
NWA	72/10/30	7410011 0046	maintenance	yes
NWA	72/12/15	7308171 0037	maintenance	yes
NWA	73/04/26	7306071 0008	pilot	yes
NWA	73/12/09	7406111 0033	pilot	yes
NWA	74/09/21	7412171 0025	passenger + WX	no
NWA	74/11/21	7601301 0037	pilot	yes
NWA	75/03/13	7606251 0043	flight attendant	yes
NWA	75/05/06	7508114 0004	other a/c	no
NWA	77/11/17	7807261 0023	pilot	yes
NWA	81/01/31	8212144 0018	maintenance	yes
NWA	81/02/11	8212141 0020	pilot	yes
NWA	81/04/09	8212144 0001	flight engineer	yes
NWA	81/07/09	8110204 0013	maintenance	yes
NWA	81/11/17	8212144 0024	maintenance	yes
NWA	83/05/26	CHI83IA228 2	maintenance	yes
NWA	84/05/17	CHI84IA196 2	maintenance	yes
NWA	84/09/29	SEA84IA233 2	maintenance	yes
NWA	84/12/04	ATL85IA047 2	maintenance	yes
NWA	85/01/26	CHI85IA097 2	maintenance	yes
NWA	85/11/28	CHI86IA034 2	maintenance	yes
NWA	86/04/03	CHI86IA115 2	manufacturer	no
NWA	86/11/05	CHI87IA026 2	manufacturer	no
NWA	86/12/01	CHI87IA039 2	pilot	yes
NWA	87/06/02	DEN87IA145A2	ATC	no
NWA	87/06/18	CHI87IA163 2	pilot	yes
NWA	87/08/16	DCA87MA046 1	pilot	yes
NWA	87/10/05	CHI88IA003 2	maintenance	yes
NWA	88/01/09	CHI88IA040 2	maintenance	yes
NWA	88/02/19	CHI88IA073A2	ATC	no
NWA	88/03/27	CHI88IA088 2	maintenance	yes
NWA	88/03/30	DCA88IA044 2	maintenance	yes
NWA	88/07/11	CHI88FA163 1	pilot	yes
NWA	88/08/05	ATL88IA227 2	maintenance	yes
NWA	88/09/09	CHI88FA233 1	pilot	yes

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A/L	Date	NTSB No.	Cause	Controllable
NWA	88/10/24	CHI89IA018 2	maintenance	yes
NWA	88/10/30	ATL89FA020 1	airport/facilities	no
PAA	64/03/05	6602194 0072	unknown	unk
PAA	64/04/07	6607071 0052	pilot	yes
PAA	64/04/11	6710251 0075	pilot	yes
PAA	64/06/08	6607074 0051	maintenance	yes
PAA	64/06/09	6810034 0011	pilot	yes
PAA	64/06/14	6607074 0024	ground crew	yes
PAA	64/09/25	6607074 0029	pilot	yes
PAA	64/11/10	6607074 0064	pilot	yes
PAA	64/12/22	6607074 0063	maintenance	yes
PAA	65/01/31	6601041 0025	pilot	yes
PAA	65/03/26	6711091 0049	unknown	unk
PAA	65/04/23	6711091 0048	pilot	yes
PAA	65/06/28	6704211 0020	maintenance	yes
PAA	65/09/17	7110181 0082	pilot	yes
PAA	65/11/20	6610064 0035	unknown	unk
PAA	65/11/25	6610064 0029	maintenance	yes
PAA	66/02/18	6610064 0009	airport/facilities	no
PAA	66/06/07	6610064 0013	pilot	yes
PAA	66/06/11	6706064 0034	pilot	yes
PAA	66/09/09	6706061 0027	pilot	yes
PAA	66/09/26	6706144 0033	maintenance	yes
PAA	66/09/30	6709151 0033	unknown	unk
PAA	66/11/15	7111091 0073	unknown	unk
PAA	67/01/03	6808094 0001	maintenance	yes
PAA	67/01/06	6808094 0004	passenger	no
PAA	67/01/19	7202104 0002	maintenance	yes
PAA	67/03/06	6807084 0032	maintenance	yes
PAA	67/05/19	6808094 0013	maintenance	yes
PAA	67/09/09	6809261 0068	unknown	unk
PAA	67/09/29	6901101 0060	unknown	unk
PAA	67/11/01	6807104 0040	pilot	yes
PAA	67/11/19	6807084 0030	maintenance	yes
PAA	68/01/13	6808271 0007	passenger + WX	no
PAA	68/01/25	7002041 0065	unknown	unk
PAA	68/01/28	6906191 0053	passenger + WX	no
PAA	68/06/13	7110181 0062	pilot	yes
PAA	68/08/14	6902241 0022	pilot	yes
PAA	68/09/14	6903071 0046	pilot	yes
PAA	68/10/28	7001141 0071	pilot	yes
PAA	68/11/23	6903141 0036	unknown	unk
PAA	68/12/12	7307191 0063	pilot	yes
PAA	68/12/26	1 0045	pilot	yes
PAA	69/02/07	7011161 0059	pilot	yes
PAA	69/02/09	7103011 0007	unknown	unk

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A/L	Date	NTSB No.	Cause	Controllable
PAA	69/02/21	7002041 0043	flight attendant	yes
PAA	69/03/20	7011161 0011	pilot	yes
PAA	69/04/22	6909264 0016	maintenance	yes
PAA	69/08/01	7103011 0063	unknown	unk
PAA	69/08/02	7002041 0039	pilot	yes
PAA	69/10/14	7210034 0049	company	yes
PAA	69/12/01	7207211 0062	pilot	yes
PAA	70/01/21	7206294 0009	company	yes
PAA	70/02/09	7204114 0016	maintenance	yes
PAA	70/08/13	7201241 0032	unknown	unk
PAA	70/10/27	7111114 0062	maintenance	yes
PAA	70/10/28	7206294 0049	ground crew	yes
PAA	70/11/04	7206291 0001	flight attendant	yes
PAA	70/11/07	7211091 0049	flight attendant	yes
PAA	70/12/13	7104014 0066	maintenance	yes
PAA	70/12/18	7204114 0067	maintenance	yes
PAA	70/12/24	7101171 0052	NWS	no
PAA	70/12/30	7101314 0068	maintenance	yes
PAA	71/01/04	7209124 0048	maintenance	yes
PAA	71/02/07	7207101 0027	pilot	yes
PAA	71/06/20	7202221 0016	pilot	yes
PAA	71/07/18	7407264 0055	pilot	yes
PAA	71/07/25	7311011 0025	unknown	unk
PAA	71/07/30	7410011 0007	pilot	yes
PAA	71/08/24	7209074 0040	maintenance	yes
PAA	72/03/08	7310181 0050	unknown	unk
PAA	72/03/08	7311011 0050	unknown	unk
PAA	72/05/24	7303024 0012	maintenance	yes
PAA	72/10/24	7304231 0036	passenger + WX	no
PAA	72/11/22	7304104 0038	pilot	yes
PAA	73/04/09	7307311 0010	maintenance	yes
PAA	73/07/22	7407181 0038	unknown	unk
PAA	73/11/03	7705101 0026	flight engineer	yes
PAA	73/12/17	7409264 0033	hijacker	no
PAA	74/01/30	7503051 0001	pilot	yes
PAA	74/02/02	7305101 0004	passenger	no
PAA	74/04/16	7503141 0042	ground crew	yes
PAA	74/04/22	7506121 0047	pilot	yes
PAA	74/07/18	7410084 0015	unknown	unk
PAA	74/11/17	7503264 0025	maintenance	yes
PAA	74/11/25	7506041 0046	unknown	unk
PAA	75/04/07	7606244 0005	maintenance	yes
PAA	75/08/06	7603051 0030	passenger + WX	no
PAA	75/09/15	7603051 0023	passenger + WX	no
PAA	75/12/14	7606244 0024	maintenance	yes
PAA	77/03/24	7804284 0009	maintenance	yes

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A/L	Date	NTSB No.	Cause	Controllable
PAA	77/03/27	7910291 0026	other a/c	no
PAA	77/06/09	7806011 0024	unknown	unk
PAA	78/09/11	7908274 0012	flight attendant	yes
PAA	79/04/21	8103171 0030	flight attendant	yes
PAA	79/06/01	8102094 0014	maintenance	yes
PAA	79/09/16	8102094 0010	pilot	yes
PAA	79/09/30	8102094 0017	no one	no
PAA	79/12/27	8103171 0004	unknown	unk
PAA	80/09/03	8203191 0017	unknown	unk
PAA	80/09/16	8203191 0016	unknown	unk
PAA	80/12/15	8109294 0017	bird	no
PAA	81/02/12	8212221 0006	ground crew	yes
PAA	81/05/20	8212141 0009	ground crew	yes
PAA	81/08/17	8209221 0023	pilot	yes
PAA	82/02/17	MIA82FA051 A	maintenance	yes
PAA	82/07/09	DCA82AA028 A	pilot	yes
PAA	83/08/21	MIA83IA210 2	maintenance	yes
PAA	83/12/14	MIA84IA045 2	maintenance	yes
PAA	84/01/01	MIA84IA054A2	ATC	no
PAA	84/01/01	MIA84IA054B2	ATC	no
PAA	84/04/14	MIA84IA140 2	manufacturer	no
PAA	84/06/11	LAX84IA349 2	maintenance	yes
PAA	86/01/27	MIA86IA066 2	maintenance	yes
PAA	86/11/06	DCA87MA010B1	other a/c	no
PAA	86/12/21	MIA87IA054 2	pilot	yes
PAA	87/07/09	NYC87IA199B2	ATC	no
PAA	87/08/09	NYC87IA227B2	ATC	no
PAA	87/10/27	MIA88IA020A2	pilot	yes
PAA	87/11/11	MIA88FA032 1	pilot	yes
PAA	88/05/23	MIA88IA176A2	ATC	no
PAA	88/07/24	MIA88IA231 2	maintenance	yes
PAA	88/09/21	NYC88IA246 2	passenger	no
PAA	88/11/03	NYC89LA072 1	flight attendant	yes
PAA	88/11/06	FTW89IA016 2	ATC	no
TWA	64/01/01	6606081 0014	pilot	yes
TWA	64/02/15	6602194 0071	bird	no
TWA	64/03/09	6603311 0021	manufacturer	no
TWA	64/05/29	6602191 0034	unknown	unk
TWA	64/07/01	6607071 0027	flight attendant	yes
TWA	64/08/21	6607074 0019	manufacturer	no
TWA	64/08/25	6607074 0021	maintenance	yes
TWA	64/08/26	6607071 0043	pilot	yes
TWA	64/09/25	6607074 0031	manufacturer	no
TWA	64/11/09	6607071 0070	pilot	yes
TWA	64/11/15	6607071 0074	maintenance	yes
TWA	64/11/23	7110181 0080	maintenance	yes

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A/L	Date	NTSB No.	Cause	Controllable
TWA	64/12/03	7011304 0077	maintenance	yes
TWA	64/12/07	6607074 0048	unknown	unk
TWA	65/02/17	6601041 0026	pilot	yes
TWA	65/03/04	6711094 0011	pilot	yes
TWA	65/03/17	6611231 0014	pilot	yes
TWA	65/05/04	6701191 0037	pilot	yes
TWA	65/07/06	6604051 0039	maintenance	yes
TWA	65/12/04	6702151 0033	other a/c	no
TWA	65/12/16	6610064 0030	maintenance	yes
TWA	66/01/05	6609064 0002	maintenance	yes
TWA	66/02/09	6610064 0008	maintenance	yes
TWA	66/10/10	6706064 0035	maintenance	yes
TWA	66/10/18	6709201 0062	copilot	yes
TWA	67/03/09	6809131 0002	pilot	yes
TWA	67/04/09	6808094 0010	maintenance	yes
TWA	67/04/25	7101131 0056	pilot	yes
TWA	67/07/15	6808094 0025	pilot	yes
TWA	67/10/17	6807084 0031	pilot	yes
TWA	67/11/06	6810241 0029	other a/c	no
TWA	67/11/20	7111091 0033	pilot	yes
TWA	68/01/31	7201264 0024	pilot	yes
TWA	68/05/18	6808104 0007	maintenance	yes
TWA	68/06/03	6906191 0057	pilot	yes
TWA	68/07/11	6901051 0027	flight attendant	yes
TWA	68/08/07	6812234 0013	maintenance	yes
TWA	69/02/02	7011161 0003	ground crew	yes
TWA	69/04/08	7001231 0029	passenger + WX	no
TWA	69/04/19	6907294 0009	maintenance	yes
TWA	69/06/05	6909204 0019	pilot	yes
TWA	69/06/25	7709131 0014	pilot	yes
TWA	69/08/29	7002191 0045	hijacker	no
TWA	69/09/15	7001231 0036	flight attendant	yes
TWA	69/10/11	7002041 0041	flight attendant	yes
TWA	69/10/12	7002041 0042	pilot	yes
TWA	70/03/19	7206294 0022	unknown	unk
TWA	70/04/22	7206294 0024	maintenance	yes
TWA	70/06/04	7206294 0026	pilot	yes
TWA	70/06/26	7206294 0030	pilot	yes
TWA	70/08/26	7104014 0051	maintenance	yes
TWA	70/09/19	7206294 0032	maintenance	yes
TWA	70/10/08	7204114 0037	maintenance	yes
TWA	70/10/16	7206304 0047	maintenance	yes
TWA	70/10/26	7204114 0042	maintenance	yes
TWA	70/10/28	7204114 0074	no one	no
TWA	70/11/30	7307091 0054	unknown	unk
TWA	71/03/19	7609104 0026	maintenance	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
TWA	71/04/01	7206011 0010	flight attendant	yes
TWA	71/06/11	7205124 0010	ATC	no
TWA	71/06/18	7208144 0037	no one	no
TWA	71/06/29	7303221 0048	hijacker	no
TWA	71/09/23	7311061 0044	pilot	yes
TWA	71/11/13	7211141 0041	pilot	yes
TWA	71/12/12	7210021 0042	pilot	yes
TWA	72/04/18	7303094 0006	maintenance	yes
TWA	72/05/23	7308174 0013	ground crew	yes
TWA	72/06/26	7303154 0017	unknown	unk
TWA	72/06/28	7304231 0028	pilot	yes
TWA	72/07/18	7402121 0027	manufacturer	no
TWA	72/07/20	7303214 0022	ATC	no
TWA	72/09/01	7211201 0013	pilot	yes
TWA	72/09/13	7306181 0022	maintenance	yes
TWA	72/11/01	7304101 0038	maintenance	yes
TWA	72/11/21	7311014 0040	maintenance	yes
TWA	72/12/12	7307181 0047	pilot	yes
TWA	73/01/10	7406284 0005	maintenance	yes
TWA	73/03/03	7404171 0005	pilot	yes
TWA	73/08/27	7401071 0020	passenger + WX	no
TWA	73/08/28	7408151 0042	manufacturer	no
TWA	74/01/16	7812031 0012	pilot	yes
TWA	74/01/17	7408131 0014	pilot	yes
TWA	74/02/16	7412041 0027	maintenance	yes
TWA	74/03/17	7506094 0005	manufacturer	no
TWA	74/04/01	7410251 0018	passenger + WX	no
TWA	74/04/01	7812151 0009	pilot	yes
TWA	74/04/19	7506124 0010	unknown	unk
TWA	74/05/04	7407164 0009	maintenance	yes
TWA	74/05/08	7506044 0008	maintenance	yes
TWA	74/09/08	7506041 0024	hijacker	no
TWA	74/10/24	7506044 0021	cargo	no
TWA	74/11/26	7503141 0041	unknown	unk
TWA	74/12/01	7602111 0029	pilot	yes
TWA	75/04/19	7511174 0006	pilot	yes
TWA	75/06/14	7603051 0019	maintenance	yes
TWA	75/07/12	7603051 0016	pilot	yes
TWA	75/08/13	7606241 0040	flight attendant	yes
TWA	75/09/11	7606244 0029	maintenance	yes
TWA	75/09/14	7606254 0019	maintenance	yes
TWA	75/10/02	7606244 0017	no one	no
TWA	75/12/22	7710051 0044	pilot	yes
TWA	76/04/24	7711231 0028	unknown	unk
TWA	76/11/17	7708251 0027	other a/c	no
TWA	77/08/31	7803014 0019	maintenance	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
TWA	77/10/27	7804284 0017	maintenance	yes
TWA	78/08/06	8007024 0024	no one	no
TWA	78/11/27	7908294 0030	pilot	yes
TWA	79/04/04	8108241 0022	pilot	yes
TWA	79/06/21	8102094 0022	pilot	yes
TWA	80/04/21	8212141 0019	pilot	yes
TWA	81/06/03	8110201 0004	ground crew	yes
TWA	82/01/12	CHI82IA026 I	maintenance	yes
TWA	82/03/08	MKC82IA042 I	maintenance	yes
TWA	82/07/28	NYC82IA170 I	pilot	yes
TWA	83/01/23	LAX83IA080 2	manufacturer	no
TWA	83/05/23	DEN83IA119 2	ground crew	yes
TWA	83/05/24	MKC83IA115 2	ground crew	yes
TWA	83/05/27	MKC83IA116 2	maintenance	yes
TWA	83/07/16	MKC83IA159 2	ground crew	yes
TWA	83/11/02	LAX84IA040 2	ground crew	yes
TWA	83/11/08	MKC84IA017 2	unknown	unk
TWA	84/06/02	NYC84IA192 2	maintenance	yes
TWA	84/11/01	LAX85IA037 2	ATC	no
TWA	85/06/11	MKC85IA131 2	maintenance	yes
TWA	86/03/22	LAX86MA151A2	other a/c	no
TWA	86/03/26	NYC86IA093 2	maintenance	yes
TWA	86/08/21	DEN86IA235 2	maintenance	yes
TWA	86/11/16	BFO87IA008 2	maintenance	yes
TWA	87/08/09	NYC87IA227A2	ATC	no
TWA	87/08/22	CHI87NA194 2	maintenance	yes
TWA	87/12/27	MIA88IA072 2	pilot	yes
TWA	88/01/19	MIA88LA090 1	passenger + WX	no
TWA	88/08/27	CHI88FA223 1	company	yes
UAL	64/01/13	6605071 0010	passenger + WX	no
UAL	64/03/11	6607074 0039	maintenance	yes
UAL	64/05/04	6501071 0025	maintenance	yes
UAL	64/05/07	6607074 0008	pilot	yes
UAL	64/06/26	6607074 0013	pilot	yes
UAL	64/07/08	6607071 0059	maintenance	yes
UAL	64/07/09	6704251 0033	unknown	unk
UAL	64/09/22	6609131 0047	ATC	no
UAL	64/09/29	6607074 0034	pilot	yes
UAL	64/10/29	6810034 0058	maintenance	yes
UAL	64/11/05	6606081 0079	maintenance	yes
UAL	64/11/05	6607074 0045	maintenance	yes
UAL	64/11/25	6602194 0062	maintenance	yes
UAL	64/11/25	6607074 0046	maintenance	yes
UAL	64/11/25	7202104 0055	maintenance	yes
UAL	64/12/02	6607074 0067	maintenance	yes
UAL	64/12/30	6906241 0072	pilot	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.		Cause	Controllable
UAL	65/01/04	6602064	0005	no one	no
UAL	65/01/24	6507231	0005	pilot	yes
UAL	65/03/03	6507064	0008	unknown	unk
UAL	65/03/04	6601041	0011	airport/facilities	no
UAL	65/03/14	6702151	0036	maintenance	yes
UAL	65/03/28	6507064	0012	pilot	yes
UAL	65/08/16	6803011	0030	unknown	unk
UAL	65/09/22	7012021	0067	bird	no
UAL	65/09/29	6610064	0033	maintenance	yes
UAL	65/10/09	6907291	0083	pilot	yes
UAL	65/10/15	6601041	0062	ground crew	yes
UAL	65/10/17	6612211	0078	unknown	unk
UAL	65/11/11	7110181	0032	pilot	yes
UAL	65/11/15	7102064	0040	maintenance	yes
UAL	65/12/22	6610061	0072	pilot	yes
UAL	66/04/01	6703214	0024	maintenance	yes
UAL	66/04/09	6707281	0048	pilot	yes
UAL	66/04/20	6702204	0019	pilot	yes
UAL	66/05/15	6706141	0037	pilot	yes
UAL	66/08/22	6707181	0053	maintenance	yes
UAL	66/08/27	7605204	0030	maintenance	yes
UAL	66/10/13	6803111	0071	pilot	yes
UAL	66/11/02	6709204	0050	pilot	yes
UAL	66/11/02	6803114	0053	pilot	yes
UAL	66/11/12	6712081	0068	flight attendant	yes
UAL	66/12/04	6709281	0063	pilot	yes
UAL	66/12/19	6706064	0048	passenger	no
UAL	67/01/19	6710121	0009	ground crew	yes
UAL	67/02/20	6808094	0026	pilot	yes
UAL	67/03/06	6807181	0013	flight attendant	yes
UAL	67/03/29	6801311	0024	company	yes
UAL	67/04/04	6908261	0016	pilot	yes
UAL	67/04/07	6801311	0022	maintenance	yes
UAL	67/04/29	6811011	0026	pilot	yes
UAL	67/05/01	6710121	0017	flight attendant	yes
UAL	67/06/07	6808094	0015	pilot	yes
UAL	67/06/08	6807104	0035	pilot	yes
UAL	67/06/09	6810241	0030	flight attendant	yes
UAL	67/06/20	6902251	0038	flight attendant	yes
UAL	67/06/26	6808291	0036	maintenance	yes
UAL	67/07/02	6807084	0033	maintenance	yes
UAL	67/09/08	6804101	0040	airport/facilities	no
UAL	67/10/18	6804101	0046	pilot	yes
UAL	67/11/07	6807084	0028	bird	no
UAL	67/11/28	6807101	0058	maintenance	yes
UAL	67/12/11	6904171	0070	pilot	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.		Cause	Controllable
UAL	68/03/21	6903071	0023	pilot	yes
UAL	68/04/02	6904171	0050	pilot	yes
UAL	68/05/15	6807244	0006	flight attendant	yes
UAL	68/06/08	6901051	0025	pilot	yes
UAL	68/06/12	6812231	0021	pilot	yes
UAL	68/07/20	6903144	0009	flight attendant	yes
UAL	68/08/05	6903071	0043	pilot	yes
UAL	68/08/06	1	0066	NWS	no
UAL	68/08/07	6902141	0037	pilot	yes
UAL	68/08/10	6809251	0018	passenger	no
UAL	68/09/06	6906191	0056	other a/c	no
UAL	68/09/26	6902014	0019	pilot	yes
UAL	68/10/03	7001141	0067	pilot	yes
UAL	68/11/16	6903144	0022	pilot	yes
UAL	68/12/13	6903074	0025	pilot	yes
UAL	68/12/21	6909124	0031	pilot	yes
UAL	69/01/07	6907314	0002	maintenance	yes
UAL	69/01/16	6912191	0022	other a/c	no
UAL	69/01/18	7103011	0004	pilot	yes
UAL	69/02/09	7011161	0015	passenger + WX	no
UAL	69/04/12	6907294	0008	maintenance	yes
UAL	69/04/28	6907294	0010	pilot	yes
UAL	69/07/26	6912191	0023	company	yes
UAL	69/07/29	7001174	0024	pilot	yes
UAL	69/10/09	7008264	0045	maintenance	yes
UAL	69/11/05	7004144	0031	pilot	yes
UAL	69/11/06	7101264	0048	pilot	yes
UAL	69/11/06	7103014	0048	other a/c	no
UAL	70/02/08	7206294	0065	pilot	yes
UAL	70/02/19	7206294	0011	copilot	yes
UAL	70/03/02	7201241	0024	maintenance	yes
UAL	70/03/26	7204114	0019	maintenance	yes
UAL	70/03/28	7206294	0046	maintenance	yes
UAL	70/05/18	7201241	0036	maintenance	yes
UAL	70/05/27	7201241	0022	pilot	yes
UAL	70/07/19	7206291	0012	maintenance	yes
UAL	70/07/22	7204114	0038	manufacturer	no
UAL	70/09/21	7211091	0034	pilot	yes
UAL	70/10/01	7204114	0072	no one	no
UAL	70/10/10	7206294	0055	flight attendant	yes
UAL	70/11/28	7211091	0046	pilot	yes
UAL	70/12/31	7101314	0080	unknown	unk
UAL	71/01/03	7207121	0028	pilot	yes
UAL	71/01/12	7112044	0002	maintenance	yes
UAL	71/01/17	7303304	0022	unknown	unk
UAL	71/02/15	7211024	0023	maintenance	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
UAL	71/03/11	7207264 0024	pilot	yes
UAL	71/05/15	7209011 0011	hijacker	no
UAL	71/06/27	7208154 0038	pilot	yes
UAL	71/07/19	7202171 0015	pilot	yes
UAL	71/07/23	7202221 0017	pilot	yes
UAL	71/07/26	7311011 0034	pilot	yes
UAL	71/08/14	7311011 0043	unknown	unk
UAL	71/08/21	7209074 0046	maintenance	yes
UAL	71/11/17	7301111 0047	maintenance	yes
UAL	71/12/04	7210024 0052	manufacturer	no
UAL	72/03/03	7410011 0024	flight attendant	yes
UAL	72/04/19	7310184 0007	no one	no
UAL	72/06/09	7307314 0009	hijacker	no
UAL	72/07/21	7303214 0021	flight attendant	yes
UAL	72/08/04	7304094 0034	maintenance	yes
UAL	72/10/01	7410011 0044	manufacturer	no
UAL	72/12/08	7402121 0048	pilot	yes
UAL	73/03/17	7401071 0007	flight attendant	yes
UAL	73/06/10	7409114 0030	copilot	yes
UAL	73/10/29	7401184 0025	maintenance	yes
UAL	74/01/04	7412061 0002	maintenance	yes
UAL	74/01/24	7506044 0002	pilot	yes
UAL	74/05/05	7506044 0011	maintenance	yes
UAL	74/09/21	7602181 0039	flight attendant	yes
UAL	74/12/15	7506044 0026	unknown	unk
UAL	75/01/08	7606244 0002	pilot	yes
UAL	75/07/17	7511174 0008	maintenance	yes
UAL	75/08/24	7606244 0016	maintenance	yes
UAL	75/10/16	7603091 0037	maintenance	yes
UAL	75/10/21	7606244 0028	maintenance	yes
UAL	76/02/16	7612211 0008	passenger + WX	no
UAL	76/02/19	7709134 0006	maintenance	yes
UAL	76/05/13	7709134 0007	no one	no
UAL	77/02/28	7804284 0012	maintenance	yes
UAL	77/04/26	7804284 0003	pilot	yes
UAL	77/06/02	7804284 0015	maintenance	yes
UAL	77/08/01	7804284 0006	pilot	yes
UAL	77/10/12	7807264 0024	ATC	no
UAL	77/12/18	7907061 0021	ATC	no
UAL	78/06/30	7810304 0010	copilot	yes
UAL	78/07/15	7908274 0027	no one	no
UAL	78/08/29	7908274 0020	maintenance	yes
UAL	78/10/27	7909284 0031	bird	no
UAL	78/11/07	7908274 0021	pilot	yes
UAL	78/11/14	7902084 0018	maintenance	yes
UAL	78/12/21	7908271 0018	flight attendant	yes

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
UAL	78/12/28	7908291 0017	pilot	yes
UAL	79/01/20	8102094 0007	maintenance	yes
UAL	79/09/15	8102094 0021	passenger	no
UAL	80/06/25	8104094 0013	pilot	yes
UAL	80/07/24	8202244 0006	maintenance	yes
UAL	80/12/29	8110201 0014	maintenance	yes
UAL	81/02/10	8212141 0002	flight attendant	yes
UAL	81/04/03	8212141 0016	pilot	yes
UAL	81/06/05	8212141 0010	flight attendant	yes
UAL	81/07/05	8212144 0012	unknown	unk
UAL	81/10/17	8209024 0021	no one	no
UAL	82/02/23	DCA82AA014 A	other a/c	no
UAL	82/04/09	CHI82IA117 I	pilot	yes
UAL	82/05/26	LAX82FA195 A	maintenance	yes
UAL	82/05/27	DEN82IA098 I	NWS	no
UAL	82/07/16	LAX82AA259 A	NWS	no
UAL	83/01/11	DCA83AA014 1	pilot	yes
UAL	83/03/11	LAX83IA140 2	maintenance	yes
UAL	83/03/30	MKC83IA083 2	pilot	yes
UAL	83/04/10	CHI83IA162 2	maintenance	yes
UAL	83/06/11	CHI83FA251 1	maintenance	yes
UAL	83/06/20	CHI83IA269A2	flight engineer	yes
UAL	83/07/05	CHI83IA299 2	manufacturer	no
UAL	83/07/20	CHI83IA327 2	pilot	yes
UAL	83/08/19	DCA83IA035 2	fuel	no
UAL	83/10/18	DEN84IA007 2	NWS	no
UAL	83/12/09	DEN84IA041 2	maintenance	yes
UAL	84/01/23	CHI84IA093 2	pilot	yes
UAL	84/05/31	DCA84AA025 1	pilot	yes
UAL	84/06/10	LAX84IA351 2	maintenance	yes
UAL	84/06/11	LAX84IA350 2	maintenance	yes
UAL	84/06/26	CHI84IA264 2	maintenance	yes
UAL	84/07/09	SEA84IA168 2	foreign object damage	unk
UAL	84/09/03	BFO84IA005A2	other a/c	no
UAL	84/10/27	CHI85IA032 2	maintenance	yes
UAL	84/11/16	DCA85AA003 1	maintenance	yes
UAL	85/09/08	BFO85IA074 2	company	yes
UAL	85/11/26	DEN86IA031 2	ground crew	yes
UAL	86/02/06	CHI86IA083 2	maintenance	yes
UAL	86/03/03	CHI86FA096 1	NWS	no
UAL	86/03/31	LAX86MA161 2	pilot	yes
UAL	86/04/08	CHI86FA119 1	maintenance	yes
UAL	86/06/24	LAX86MA275 2	unknown	unk
UAL	86/10/05	SEA87IA003 2	maintenance	yes
UAL	86/10/29	LAX87IA027A2	other a/c	no
UAL	86/11/12	ATL87IA020B2	other a/c	no

APPENDIX B

DETERMINATIONS
(continued)

A/L	Date	NTSB No.	Cause	Controllable
UAL	86/12/15	ANC87FA021 1	flight attendant	yes
UAL	87/01/25	CHI87IA067 2	maintenance	yes
UAL	87/02/11	CHI87FA081 1	hijacker	no
UAL	87/04/07	CHI87IA109 2	pilot	yes
UAL	87/06/22	LAX87LA243B1	maintenance	yes
UAL	87/09/02	CHI87IA201 2	maintenance	yes
UAL	87/10/28	CHI88IA011 2	maintenance	yes
UAL	87/10/29	CHI88IA015A2	ATC	no
UAL	88/05/02	DCA88IA056 2	flight engineer	yes
UAL	88/05/11	CHI88IA111 2	maintenance	yes
UAL	88/06/26	BFO88LA061 1	passenger + WX	no
UAL	88/08/10	MKC88FA154 1	maintenance	yes
UAL	88/12/23	LAX89LA068 1	NWS	no

APPENDIX B

DETERMINATIONS
(continued)

Cause	No.	Controllable
Pilot	337	yes
Co-pilot	20	yes
Flight engineer	5	yes
Flight Attendant	71	yes
Company	12	yes
Maintenance	344	yes
Ground Crew	25	yes
Pilot and Maintenance	2	yes
Total Controllable	816	
Passenger	53	no
Manufacturer	40	no
ATC	37	no
Other Aircraft	28	no
No one	27	no
NWS	17	no
Hijacker	13	no
Airport/Facilities	13	no
Bird	11	no
Cargo	5	no
Stow-away	1	no
Fuel	1	no
Total Not Controllable	245	
Unknown	54	unk
Foreign Object Damage	2	unk
Total Unknown	56	
Total	1,118	

APPENDIX C

ORDINARY LEAST SQUARES (OLS)

APPENDIX C

ORDINARY LEAST SQUARES (OLS)

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controllable rate
genr  crate     =  ((1000000*y))/hours

* generate log of the controllable rate
genr  lncrate  =  log(crate)

* generate time since deregulation dummy
genr timedum   = d*(year - 79)
print y hours crate lncrate year  d timedum


ols   lncrate   year                  /exactdw
ols   lncrate   year  d               /exactdw
ols   lncrate   year     timedum      /exactdw
ols   lncrate   year  d  timedum      /exactdw

delete  / all
```

APPENDIX C

ORDINARY LEAST SQUARES (OLS)
(continued)

```
FILE 11  d:\shazam\d\f1\fatacc.doc
sample 1 27
read(11) year fatal acc hours

* generate zero dummy
genr zerodum  =  dum(.1 - fatal)

* generate fatal accident rate
genr  fatrate    =  (1000000*(fatal + zerodum))/hours

* generate log of the fatrate
genr  lnfatrat  =  log(fatrate)

* generate accident rate
genr  accrate    =  (1000000*acc)/hours

* generate log of the accident rate
genr  lnaccrat  =  log(accrate)

* generate deregulation dummy
genr d    = dum(year - 79.9)

genr timedum   = d*(year - 79)

print year  fatal fatrate lnfatrat zerodum hours
print year  acc accrate   lnaccrat d timedum

ols   lnaccrat   year                          /exactdw
ols   lnaccrat   year              d           /exactdw
ols   lnaccrat   year                 timedum  /exactdw
ols   lnaccrat   year              d  timedum  /exactdw

ols   lnfatrat   year   zerodum                /exactdw
ols   lnfatrat   year   zerodum    d           /exactdw
ols   lnfatrat   year   zerodum       timedum  /exactdw
ols   lnfatrat   year   zerodum    d  timedum  /exactdw

delete  / all
stop
```

APPENDIX C

ORDINARY LEAST SQUARES (OLS)
(continued)

OUTPUT FILE

```
LOADING SHAZAM EXTENDED MEMORY Version 6.2                    OS386
v2.1.06

 Date:03/16/93 Time:07:14:37.14
 *********************************************************************
 * SHAZAM - FOR 386/486 EXTENDED MEMORY SITE NO. 1438A4X             *
 *                                                                   *
 * ** Copyright (C)  1991  by K.J. White - All Rights Reserved **    *
 *                                                                   *
 * FOR USE ONLY BY: William C. De Jager                              *
 * AT: Beaverton, Oregon                                             *
 *                                                                   *
 *                                                                   *
 * If this does not describe you then you have stolen this copy      *
 * and if you type anything except STOP or HELP SHAZAM you           *
 * agree to send payment within 7 days for a software license        *
 *                                                                   *
 *                                                                   *
 *                                                                   *
 * FOR USE ON SINGLE COMPUTER ONLY - NO COPIES PERMITTED             *
 *********************************************************************
 Hello/Bonjour/Aloha/Howdy/G Day/Kia Ora/Konnichiwa/Buenos Dias/Nee Hau
 Welcome to SHAZAM - Version 6.2  -  NOV 1991 SYSTEM=OS386    PAR=  500
```

APPENDIX C

ORDINARY LEAST SQUARES (OLS) (continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

Y	HOURS	CRATE	LNCRATE	YR	D	TIMEDUM
64	2441185.	26.21678	3.266400	64	0.00	0.00
45	2691129.	16.72161	2.816702	65	0.00	0.00
45	2819170.	15.96214	2.770220	66	0.00	0.00
48	3507054.	13.68670	2.616425	67	0.00	0.00
43	4015838.	10.70760	2.370954	68	0.00	0.00
44	4336713.	10.14593	2.317073	69	0.00	0.00
44	4294706.	10.24517	2.326807	70	0.00	0.00
48	4224634.	11.36193	2.430268	71	0.00	0.00
40	4204233.	9.514221	2.252788	72	0.00	0.00
30	4346571.	6.901992	1.931810	73	0.00	0.00
34	3997587.	8.505131	2.140670	74	0.00	0.00
36	3936489.	9.145205	2.213230	75	0.00	0.00
14	4024069.	3.479066	1.246764	76	0.00	0.00
20	4135728.	4.835908	1.576069	77	0.00	0.00
20	4166439.	4.800262	1.568671	78	0.00	0.00
14	4329449.	3.233668	1.173617	79	0.00	0.00
9.	4439343.	2.027327	0.7067182	80	1.0	1.0
27	4049954.	6.666742	1.897131	81	1.0	2.0
15	4016962.	3.734165	1.317524	82	1.0	3.0
32	4197657.	7.623300	2.031209	83	1.0	4.0
24	4547810.	5.277265	1.663408	84	1.0	5.0
25	4744502.	5.269257	1.661889	85	1.0	6.0
26	5389885.	4.823851	1.573572	86	1.0	7.0
36	6921046.	5.201526	1.648952	87	1.0	8.0
33	7166746.	4.604600	1.527056	88	1.0	9.0

APPENDIX C

ORDINARY LEAST SQUARES (OLS)
(continued)

OLS ESTIMATION

25 OBSERVATIONS DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC = 1.25148
DURBIN-WATSON PROBABILITY = 0.013625
R-SQUARE = 0.5997 R-SQUARE ADJUSTED = 0.5823
SUM OF SQUARED ERRORS-SSE= 3.3596

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.62229E-01	0.10600E-01	-5.8706	-0.7744	-0.77443	-2.4107
CONSTANT	6.6912	0.80922	8.2687	0.8650	0.00000	3.4107

25 OBSERVATIONS DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC = 1.62760
DURBIN-WATSON PROBABILITY = 0.084513
R-SQUARE = 0.6485 R-SQUARE ADJUSTED = 0.6165
SUM OF SQUARED ERRORS-SSE= 2.9506

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.88835E-01	0.18311E-01	-4.8514	-0.7189	-1.1055	-3.4414
D	0.48039	0.27509	1.7463	0.3489	0.39795	0.88153E-01
CONSTANT	8.5404	1.3124	6.5072	0.8112	0.00000	4.3533

25 OBSERVATIONS DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC = 2.38251
DURBIN-WATSON PROBABILITY = 0.699334
R-SQUARE = 0.7983 R-SQUARE ADJUSTED = 0.7800
SUM OF SQUARED ERRORS-SSE= 1.6928

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11270	0.13295E-01	-8.4764	-0.8750	-1.4025	-4.3658
TIMEDUM	0.15621	0.33563E-01	4.6543	0.7044	0.77010	0.14332
CONSTANT	10.246	0.96341	10.635	0.9150	0.00000	5.2225

25 OBSERVATIONS DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC = 2.37669
DURBIN-WATSON PROBABILITY = 0.626381
R-SQUARE = 0.7983 R-SQUARE ADJUSTED = 0.7695
SUM OF SQUARED ERRORS-SSE= 1.6927

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 21 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11239	0.15397E-01	-7.2997	-0.8469	-1.3987	-4.3540
D	-0.10398E-01	0.24681	-0.42131E-01	-0.0092	-0.86137E-02	-0.19081E-02
TIMEDUM	0.15705	0.39755E-01	3.9505	0.6529	0.77425	0.14410
CONSTANT	10.225	1.1032	9.2685	0.8964	0.00000	5.2118

APPENDIX C

ORDINARY LEAST SQUARES (OLS) (continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\fatacc.doc

4 VARIABLES AND 27 OBSERVATIONS STARTING AT OBS 1

YR	FATAL	FATRATE	LNFATRAT	ZERODUM	HOURS
61	6.	1.641810	0.4957994	0.00	3654503.
62	6.	1.718620	0.5415214	0.00	3491174.
63	6.	1.664712	0.5096519	0.00	3604228.
64	11	2.914084	1.069556	0.00	3774771.
65	8.	1.964643	0.6753105	0.00	4071987.
66	5.	1.181200	0.1665312	0.00	4232982.
67	8.	1.624669	0.4853041	0.00	4924080.
68	13	2.354249	0.8562217	0.00	5521931.
69	8.	1.357715	0.3058029	0.00	5892254.
70	4.	0.6919813	-0.3681963	0.00	5780503.
71	7.	1.226721	0.2043446	0.00	5706270.
72	7.	1.236862	0.2125773	0.00	5659485.
73	8.	1.356260	0.3047307	0.00	5898575.
74	7.	1.278657	0.2458101	0.00	5474495.
75	2.	0.3688223	-0.9974402	0.00	5422665.
76	2.	0.3579354	-1.027403	0.00	5587601.
77	3.	0.5171662	-0.6593910	0.00	5800843.
78	4.	0.6631582	-0.4107417	0.00	6031743.
79	5.	0.7462328	-0.2927177	0.00	6700322.
80	0.0	0.1471112	-1.916566	1.0	6797578.
81	4.	0.6087087	-0.4964155	0.00	6571288.
82	3.	0.4658267	-0.7639416	0.00	6440163.
83	4.	0.6015934	-0.5081735	0.00	6649009.
84	1.	0.1344358	-2.006669	0.00	7438497.
85	4.	0.5033070	-0.6865549	0.00	7947435.
86	1.	0.1068729	-2.236115	0.00	9356906.
87	4.	0.4119040	-0.8869649	0.00	9711000.

APPENDIX C

ORDINARY LEAST SQUARES (OLS)
(continued)

YR	ACC	ACCRATE	LNACCRAT	D	TIMEDUM
61.	66	18.05991	2.893695	0.00	0.00
62.	47	13.46252	2.599910	0.00	0.00
63.	54	14.98240	2.706876	0.00	0.00
64.	59	15.63009	2.749198	0.00	0.00
65.	65	15.96272	2.770256	0.00	0.00
66.	56	13.22944	2.582445	0.00	0.00
67.	54	10.96652	2.394847	0.00	0.00
68.	56	10.14138	2.316624	0.00	0.00
69.	51	8.655431	2.158187	0.00	0.00
70.	43	7.438799	2.006709	0.00	0.00
71.	43	7.535571	2.019635	0.00	0.00
72.	46	8.127948	2.095308	0.00	0.00
73.	36	6.103169	1.808808	0.00	0.00
74.	43	7.854606	2.061100	0.00	0.00
75.	30	5.532335	1.710610	0.00	0.00
76.	22	3.937289	1.370492	0.00	0.00
77.	20	3.447775	1.237729	0.00	0.00
78.	20	3.315791	1.198696	0.00	0.00
79.	23	3.432671	1.233339	0.00	0.00
80.	15	2.206668	0.7914838	1.0	1.0
81.	25	3.804429	1.336166	1.0	2.0
82.	15	2.329134	0.8454964	1.0	3.0
83.	22	3.308764	1.196575	1.0	4.0
84.	12	1.613229	0.4782378	1.0	5.0
85.	17	2.139055	0.7603641	1.0	6.0
86.	20	2.137459	0.7596176	1.0	7.0
87.	30	3.089280	1.127938	1.0	8.0

APPENDIX C

ORDINARY LEAST SQUARES (OLS) (continued)

OLS ESTIMATION

27 OBSERVATIONS DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC = 1.80983
DURBIN-WATSON PROBABILITY = 0.236618
R-SQUARE = 0.9172 R-SQUARE ADJUSTED = 0.9138
SUM OF SQUARED ERRORS-SSE= 1.1679

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 25 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.88846E-01	0.53405E-02	-16.636	-0.9577	-0.95768	-3.7601
CONSTANT	8.3231	0.39738	20.945	0.9727	0.00000	4.7601

27 OBSERVATIONS DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC = 1.83163
DURBIN-WATSON PROBABILITY = 0.198224
R-SQUARE = 0.9173 R-SQUARE ADJUSTED = 0.9104
SUM OF SQUARED ERRORS-SSE= 1.1662

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 24 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.90168E-01	0.89107E-02	-10.119	-0.9001	-0.97193	-3.8160
D	0.28490E-01	0.15199	0.18744	0.0382	0.18003E-01	0.48277E-02
CONSTANT	8.4125	0.62580	13.443	0.9396	0.00000	4.8112

27 OBSERVATIONS DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC = 2.06439
DURBIN-WATSON PROBABILITY = 0.393702
R-SQUARE = 0.9285 R-SQUARE ADJUSTED = 0.9226
SUM OF SQUARED ERRORS-SSE= 1.0078

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 24 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10040	0.77855E-02	-12.895	-0.9348	-1.0822	-4.2489
TIMEDUM	0.49267E-01	0.25228E-01	1.9529	0.3703	0.16389	0.37568E-01
CONSTANT	9.1121	0.55242	16.495	0.9586	0.00000	5.2113

27 OBSERVATIONS DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC = 2.06226
DURBIN-WATSON PROBABILITY = 0.325728
R-SQUARE = 0.9340 R-SQUARE ADJUSTED = 0.9254
SUM OF SQUARED ERRORS-SSE= 0.93054

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.95495E-01	0.84249E-02	-11.335	-0.9210	-1.0294	-4.0415
D	-0.24890	0.18012	-1.3818	-0.2769	-0.15728	-0.42177E-01
TIMEDUM	0.77622E-01	0.32160E-01	2.4136	0.4496	0.25821	0.59190E-01
CONSTANT	8.7854	0.59155	14.852	0.9516	0.00000	5.0244

APPENDIX C

ORDINARY LEAST SQUARES (OLS) (continued)

27 OBSERVATIONS DEPENDENT VARIABLE = LNFATRAT
DURBIN-WATSON STATISTIC = 2.31694
DURBIN-WATSON PROBABILITY = 0.736955
R-SQUARE = 0.7295 R-SQUARE ADJUSTED = 0.7069
SUM OF SQUARED ERRORS-SSE= 5.3403

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 24 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.85020E-01	0.11791E-01	-7.2109	-0.8272	-0.77449	23.645
ZERODUM	-1.1842	0.48628	-2.4353	-0.4451	-0.26156	0.16484
CONSTANT	6.0693	0.87468	6.9388	0.8169	0.00000	-22.810

27 OBSERVATIONS DEPENDENT VARIABLE = LNFATRAT
DURBIN-WATSON STATISTIC = 2.31715
DURBIN-WATSON PROBABILITY = 0.662994
R-SQUARE = 0.7296 R-SQUARE ADJUSTED = 0.6943
SUM OF SQUARED ERRORS-SSE= 5.3371

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.83196E-01	0.19699E-01	-4.2234	-0.6609	-0.75787	23.138
ZERODUM	-1.1658	0.52097	-2.2378	-0.4228	-0.25749	0.16227
D	-0.40763E-01	0.34845	-0.11698	-0.0244	-0.21769E-01	0.45393E-01
CONSTANT	5.9457	1.3833	4.2981	0.6674	0.00000	-22.346

27 OBSERVATIONS DEPENDENT VARIABLE = LNFATRAT
DURBIN-WATSON STATISTIC = 2.33838
DURBIN-WATSON PROBABILITY = 0.681875
R-SQUARE = 0.7337 R-SQUARE ADJUSTED = 0.6990
SUM OF SQUARED ERRORS-SSE= 5.2558

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.76168E-01	0.18831E-01	-4.0449	-0.6447	-0.69385	21.183
ZERODUM	-1.2521	0.50526	-2.4781	-0.4591	-0.27655	0.17429
TIMEDUM	-0.36700E-01	0.60341E-01	-0.60822	-0.1258	-0.10317	0.18391
CONSTANT	5.4656	1.3307	4.1075	0.6505	0.00000	-20.541

27 OBSERVATIONS DEPENDENT VARIABLE = LNFATRAT
DURBIN-WATSON STATISTIC = 2.36679
DURBIN-WATSON PROBABILITY = 0.636887
R-SQUARE = 0.7369 R-SQUARE ADJUSTED = 0.6891
SUM OF SQUARED ERRORS-SSE= 5.1925

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.79749E-01	0.20349E-01	-3.9191	-0.6412	-0.72647	22.179
ZERODUM	-1.4465	0.63609	-2.2741	-0.4363	-0.31949	0.20135
D	0.27908	0.53890	0.51788	0.1097	0.14904	-0.31078
TIMEDUM	-0.73622E-01	0.94039E-01	-0.78288	-0.1646	-0.20697	0.36892
CONSTANT	5.7044	1.4288	3.9925	0.6482	0.00000	-21.439

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controlable rate
genr  crate    =  ((1000000*y))/hours

* generate log crate
genr  lncrate =  log(crate)

* generate time since deregulation dummy
genr timedum   = d*(year - 79)

print y hours crate lncrate year  d timedum


nl 1 /ncoef=2
eq lncrate = yr * year                                      +    const
coef         yr .1                                               const 200

nl 1 /ncoef=3
eq lncrate = yr * year + dummy * d                          +    const
coef         yr .1       dummy .1                                const 200

nl 1 /ncoef=3
eq lncrate = yr * year                + tdum * timedum +   const
coef         yr .1                      tdum .1            const 200

nl 1 /ncoef=4
eq lncrate = yr * year + dummy * d  + tdum * timedum +   const
coef         yr .1       dummy .1     tdum .1            const 200

delete /all
```

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR) (continued)

```
FILE 11  d:\shazam\d\f1\fatacc.doc
sample 1 27
read(11) year fat acc hours

* generate zero dummy
genr  zerodum  = dum(.1 - fat)

* generate fatal accident rate
genr  fatrate   = (1000000*(fat + zerodum))/hours

* generate log fatrate
genr lnfatrat   =  log(fatrate)

* generate accident rate
genr  accrate   =  ((1000000*acc))/hours

* generate log accident rate
genr  lnaccrat  =  log(accrate)

* generate deregulation dummy
genr d          = dum(year - 79.9)

* generate time since deregulation dummy
genr timedum    = d*(year - 79)

print year fat fatrate d timedum zerodum
print year acc accrate d timedum hours


nl 1 /ncoef=2
eq lnaccrat = yr * year                                  +   const
coef          yr .1                                          const 200

nl 1 /ncoef=3
eq lnaccrat = yr * year + dummy * d                      +   const
coef          yr .1       dummy .1                           const 200

nl 1 /ncoef=3
eq lnaccrat = yr * year               + tdum * timedum +     const
coef          yr .1                     tdum .1              const 200

nl 1 /ncoef=4
eq lnaccrat = yr * year + dummy * d   + tdum * timedum +     const
coef          yr .1       dummy .1      tdum .1              const 200
```

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

```
nl 1 /ncoef=3
eq lnfatrat = yr * year +                                 zd * zerodum + const
coef          yr .1                                     zd 1           const 200

nl 1 /ncoef=4
eq lnfatrat = yr * year + dummy * d                     + zd * zerodum + const
coef          yr .1       dummy .1                        zd 1           const 200

nl 1 /ncoef=4
eq lnfatrat = yr * year             + tdum * timedum + zd * zerodum + const
coef          yr .1                   tdum .1          zd 1           const 200

nl 1 /ncoef=5
eq lnfatrat = yr * year + dummy * d + tdum * timedum + zd * zerodum + const
coef          yr .1       dummy .1    tdum .1          zd 1           const 200
```

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

Y	HOURS	CRATE	LNCRATE	YR	D	TIMEDUM
64	2441185	26.21678	3.266400	64	0.0	0.00
45	2691129	16.72161	2.816702	65	0.0	0.00
45	2819170	15.96214	2.770220	66	0.0	0.00
48	3507054	13.68670	2.616425	67	0.0	0.00
43	4015838	10.70760	2.370954	68	0.0	0.00
44	4336713	10.14593	2.317073	69	0.0	0.00
44	4294706	10.24517	2.326807	70	0.0	0.00
48	4224634	11.36193	2.430268	71	0.0	0.00
40	4204233	9.514221	2.252788	72	0.0	0.00
30	4346571	6.901992	1.931810	73	0.0	0.00
34	3997587	8.505131	2.140670	74	0.0	0.00
36	3936489	9.145205	2.213230	75	0.0	0.00
14	4024069	3.479066	1.246764	76	0.0	0.00
20	4135728	4.835908	1.576069	77	0.0	0.00
20	4166439	4.800262	1.568671	78	0.0	0.00
14	4329449	3.233668	1.173617	79	0.0	0.00
9.	4439343	2.027327	0.7067182	80	1.	1.0
27	4049954	6.666742	1.897131	81	1.	2.0
15	4016962	3.734165	1.317524	82	1.	3.0
32	4197657	7.623300	2.031209	83	1.	4.0
24	4547810	5.277265	1.663408	84	1.	5.0
25	4744502	5.269257	1.661889	85	1.	6.0
26	5389885	4.823851	1.573572	86	1.	7.0
36	6921046	5.201526	1.648952	87	1.	8.0
33	7166746	4.604600	1.527056	88	1.	9.0

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

```
   2 VARIABLES IN  1 EQUATIONS WITH  2 COEFFICIENTS
 LOG-LIKELIHOOD FUNCTION=   -10.38533
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.13438
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.62229E-01 0.10171E-01 -6.1184
 CONST     6.6912      0.77641     8.6181

   3 VARIABLES IN  1 EQUATIONS WITH  3 COEFFICIENTS
 LOG-LIKELIHOOD FUNCTION=   -8.762643
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.11802
      COEFFICIENT    ST. ERROR   T-RATIO

 YR      -0.88835E-01 0.17178E-01 -5.1716
 DUMMY    0.48039     0.25806      1.8616
 CONST     8.5404      1.2312      6.9367

   3 VARIABLES IN  1 EQUATIONS WITH  3 COEFFICIENTS
 LOG-LIKELIHOOD FUNCTION=   -1.817325
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.67712E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.11270     0.12754E-01 -8.8361
 TDUM     0.15621     0.31994E-01  4.8824
 CONST     10.246     0.92419      11.086

   4 VARIABLES IN  1 EQUATIONS WITH  4 COEFFICIENTS
 LOG-LIKELIHOOD FUNCTION=   -1.816268
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.67706E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.11239     0.14499E-01 -7.7518
 DUMMY   -0.10398E-01 0.23029     -0.45152E-01
 TDUM     0.15705     0.36996E-01  4.2452
 CONST     10.225      1.0365      9.8651
```

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\fatacc.doc

4 VARIABLES AND 27 OBSERVATIONS STARTING AT OBS 1

YEAR	FAT	FATRATE	D	TIMEDUM	ZERODUM
61	6.000000	1.641810	0.0	0.00000	0.0
62	6.000000	1.718620	0.0	0.00000	0.0
63	6.000000	1.664712	0.0	0.00000	0.0
64	11.00000	2.914084	0.0	0.00000	0.0
65	8.000000	1.964643	0.0	0.00000	0.0
66	5.000000	1.181200	0.0	0.00000	0.0
67	8.000000	1.624669	0.0	0.00000	0.0
68	13.00000	2.354249	0.0	0.00000	0.0
69	8.000000	1.357715	0.0	0.00000	0.0
70	4.000000	0.6919813	0.0	0.00000	0.0
71	7.000000	1.226721	0.0	0.00000	0.0
72	7.000000	1.236862	0.0	0.00000	0.0
73	8.000000	1.356260	0.0	0.00000	0.0
74	7.000000	1.278657	0.0	0.00000	0.0
75	2.000000	0.3688223	0.0	0.00000	0.0
76	2.000000	0.3579354	0.0	0.00000	0.0
77	3.000000	0.5171662	0.0	0.00000	0.0
78	4.000000	0.6631582	0.0	0.00000	0.0
79	5.000000	0.7462328	0.0	0.00000	0.0
80	0.0000000	0.1471112	1.	1.0000	1.
81	4.000000	0.6087087	1.	2.0000	0.0
82	3.000000	0.4658267	1.	3.0000	0.0
83	4.000000	0.6015934	1.	4.0000	0.0
84	1.000000	0.1344358	1.	5.0000	0.0
85	4.000000	0.5033070	1.	6.0000	0.0
86	1.000000	0.1068729	1.	7.0000	0.0
87	4.000000	0.4119040	1.	8.0000	0.0

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

YEAR	ACC	ACCRATE	D	TIMEDUM	HOURS
61	66	18.05991	0.00	0.00000	3654503
62	47	13.46252	0.00	0.00000	3491174
63	54	14.98240	0.00	0.00000	3604228
64	59	15.63009	0.00	0.00000	3774771
65	65	15.96272	0.00	0.00000	4071987
66	56	13.22944	0.00	0.00000	4232982
67	54	10.96652	0.00	0.00000	4924080
68	56	10.14138	0.00	0.00000	5521931
69	51	8.655431	0.00	0.00000	5892254
70	43	7.438799	0.00	0.00000	5780503
71	43	7.535571	0.00	0.00000	5706270
72	46	8.127948	0.00	0.00000	5659485
73	36	6.103169	0.00	0.00000	5898575
74	43	7.854606	0.00	0.00000	5474495
75	30	5.532335	0.00	0.00000	5422665
76	22	3.937289	0.00	0.00000	5587601
77	20	3.447775	0.00	0.00000	5800843
78	20	3.315791	0.00	0.00000	6031743
79	23	3.432671	0.00	0.00000	6700322
80	15	2.206668	1.0	1.0000	6797578
81	25	3.804429	1.0	2.0000	6571288
82	15	2.329134	1.0	3.0000	6440163
83	22	3.308764	1.0	4.0000	6649009
84	12	1.613229	1.0	5.0000	7438497
85	17	2.139055	1.0	6.0000	7947435
86	20	2.137459	1.0	7.0000	9356906
87	30	3.089280	1.0	8.0000	9711000

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR) (continued)

```
   2 VARIABLES IN  1 EQUATIONS WITH  2 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION=    4.086653
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.43257E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.88846E-01 0.51409E-02 -17.282
 CONST     8.3231      0.38241      21.765

   3 VARIABLES IN  1 EQUATIONS WITH  3 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION=    4.106401
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.43194E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.90168E-01 0.84814E-02 -10.631
 DUMMY    0.28490E-01 0.14830     0.19211
 CONST     8.4125      0.59454      14.150

   3 VARIABLES IN  1 EQUATIONS WITH  3 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION=    6.077580
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.37326E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.10040      0.73838E-02 -13.597
 TDUM     0.49267E-01 0.23846E-01  2.0660
 CONST     9.1121      0.52389      17.393

   4 VARIABLES IN  1 EQUATIONS WITH  4 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION=    7.154268
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED =  0.34465E-01
      COEFFICIENT    ST. ERROR   T-RATIO
 YR      -0.95495E-01 0.78265E-02 -12.201
 DUMMY   -0.24890      0.16678     -1.4924
 TDUM     0.77622E-01 0.30711E-01  2.5275
 CONST     8.7854      0.55014      15.970
```

APPENDIX D

MAXIMUM LIKELIHOOD (USING SHAZAM NON-LINEAR)
(continued)

3 VARIABLES IN 1 EQUATIONS WITH 3 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION= -16.43384
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED = 0.19779

	COEFFICIENT	ST. ERROR	T-RATIO
YR	-0.85020E-01	0.11166E-01	-7.6140
ZD	-1.1842	0.46375	-2.5536
CONST	6.0693	0.82768	7.3328

4 VARIABLES IN 1 EQUATIONS WITH 4 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION= -16.42581
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED = 0.19767

	COEFFICIENT	ST. ERROR	T-RATIO
YR	-0.83196E-01	0.18752E-01	-4.4367
DUMMY	-0.40763E-01	0.32813	-0.12423
ZD	-1.1658	0.48374	-2.4100
CONST	5.9457	1.3185	4.5094

4 VARIABLES IN 1 EQUATIONS WITH 4 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION= -16.21843
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED = 0.19466

	COEFFICIENT	ST. ERROR	T-RATIO
YR	-0.76168E-01	0.17505E-01	-4.3511
TDUM	-0.36700E-01	0.55952E-01	-0.65592
ZD	-1.2521	0.47203	-2.6526
CONST	5.4656	1.2374	4.4172

5 VARIABLES IN 1 EQUATIONS WITH 5 COEFFICIENTS
LOG-LIKELIHOOD FUNCTION= -16.05485
MAXIMUM LIKELIHOOD ESTIMATE OF SIGMA-SQUARED = 0.19231

	COEFFICIENT	ST. ERROR	T-RATIO
YR	-0.79749E-01	0.18532E-01	-4.3034
DUMMY	0.27908	0.49725	0.56125
TDUM	-0.73622E-01	0.85785E-01	-0.85821
ZD	-1.4465	0.59528	-2.4299
CONST	5.7044	1.3018	4.3821

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controlable rate
genr  crate    =  ((1000000*y))/hours

* generate square root crate
genr  sqrtcrat =  sqrt(crate)

* generate time since deregulation dummy
genr timedum   = d*(year - 79)

print y hours crate sqrtcrat year  d timedum


Ols sqrtcrat  year d         /exactdw
ols sqrtcrat  year   timedum /exactdw
ols sqrtcrat  year d  timedum /exactdw

delete /all
```

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE (continued)

```
FILE 11  d:\shazam\d\f1\fatacc.doc
sample 1 27
read(11) year fat acc hours

* generate fatal accident rate
genr  fatrate   = (1000000*fat)/hours

* generate squareroot fatrate
genr sqrtfatr   =  sqrt(fatrate)

* generate accident rate
genr  accrate   =  ((1000000*acc))/hours

* generate sqrt accident rate
genr  sqrtaccr  =  sqrt(accrate)

* generate deregulation dummy
genr d          = dum(year - 79.9)

* generate time since deregulation dummy
genr timedum    = d*(year - 79)

print year fat fatrate d timedum
print year acc accrate d timedum hours

ols sqrtaccr  year  d            /exactdw

Ols sqrtaccr  year     timedum   /exactdw

Ols sqrtaccr  year  d  timedum   /exactdw

ols sqrtfatr  year  d            /exactdw

Ols sqrtfatr  year     timedum   /exactdw

Ols sqrtfatr  year  d  timedum   /exactdw

delete /all
```

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

Y	HOURS	CRATE	SQRTCRAT	YR	D	TIMEDUM
64	2441185.	26.21678	5.120232	64	0.00	0.00
45	2691129.	16.72161	4.089206	65	0.00	0.00
45	2819170.	15.96214	3.995265	66	0.00	0.00
48	3507054.	13.68670	3.699554	67	0.00	0.00
43	4015838.	10.70760	3.272247	68	0.00	0.00
44	4336713.	10.14593	3.185268	69	0.00	0.00
44	4294706.	10.24517	3.200808	70	0.00	0.00
48	4224634.	11.36193	3.370746	71	0.00	0.00
40	4204233.	9.514221	3.084513	72	0.00	0.00
30	4346571.	6.901992	2.627164	73	0.00	0.00
34	3997587.	8.505131	2.916356	74	0.00	0.00
36	3936489.	9.145205	3.024104	75	0.00	0.00
14	4024069.	3.479066	1.865225	76	0.00	0.00
20	4135728.	4.835908	2.199070	77	0.00	0.00
20	4166439.	4.800262	2.190950	78	0.00	0.00
14	4329449.	3.233668	1.798240	79	0.00	0.00
9.	4439343.	2.027327	1.423842	80	1.0	1.00
27	4049954.	6.666742	2.582004	81	1.0	2.00
15	4016962.	3.734165	1.932399	82	1.0	3.00
32	4197657.	7.623300	2.761032	83	1.0	4.00
24	4547810.	5.277265	2.297230	84	1.0	5.00
25	4744502.	5.269257	2.295486	85	1.0	6.00
26	5389885.	4.823851	2.196327	86	1.0	7.00
36	6921046.	5.201526	2.280685	87	1.0	8.00
33	7166746.	4.604600	2.145833	88	1.0	9.00

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE (continued)

OLS ESTIMATION
25 OBSERVATIONS DEPENDENT VARIABLE = SQRTCRAT
DURBIN-WATSON STATISTIC = 1.45116
DURBIN-WATSON PROBABILITY = 0.032192
R-SQUARE = 0.7198 R-SQUARE ADJUSTED = 0.6943
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.21887
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.46783
SUM OF SQUARED ERRORS-SSE= 4.8151
MEAN OF DEPENDENT VARIABLE = 2.7822
LOG OF THE LIKELIHOOD FUNCTION = -14.8845

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.13971	0.23392E-01	-5.9728	-0.7865	-1.2153	-3.8165
D	0.85674	0.35142	2.4380	0.4612	0.49604	0.11086
CONSTANT	13.092	1.6766	7.8086	0.8572	0.00000	4.7057

OLS ESTIMATION
25 OBSERVATIONS DEPENDENT VARIABLE = SQRTCRAT
DURBIN-WATSON STATISTIC = 2.01000
DURBIN-WATSON PROBABILITY = 0.330309
R-SQUARE = 0.8402 R-SQUARE ADJUSTED = 0.8257
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.12478
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.35324
SUM OF SQUARED ERRORS-SSE= 2.7452
MEAN OF DEPENDENT VARIABLE = 2.7822
LOG OF THE LIKELIHOOD FUNCTION = -7.86054

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.16403	0.16931E-01	-9.6883	-0.9001	-1.4268	-4.4809
TIMEDUM	0.22214	0.42740E-01	5.1975	0.7424	0.76544	0.14372
CONSTANT	14.849	1.2269	12.103	0.9324	0.00000	5.3371

OLS ESTIMATION
25 OBSERVATIONS DEPENDENT VARIABLE = SQRTCRAT
DURBIN-WATSON STATISTIC = 2.13590
DURBIN-WATSON PROBABILITY = 0.379236
R-SQUARE = 0.8439 R-SQUARE ADJUSTED = 0.8216
SUM OF SQUARED ERRORS-SSE= 2.6825

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 21 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.17039	0.19383E-01	-8.7906	-0.8867	-1.4821	-4.6545
D	0.21770	0.31070	0.70068	0.1511	0.12605	0.28170E-01
TIMEDUM	0.20449	0.50046E-01	4.0861	0.6655	0.70462	0.13230
CONSTANT	15.285	1.3887	11.006	0.9232	0.00000	5.4940

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\fatacc.doc

4 VARIABLES AND 27 OBSERVATIONS STARTING AT OBS 1

YR	FAT	FATRATE	D	TIMEDUM
61	6.000000	1.641810	0.0000000	0.0000000
62	6.000000	1.718620	0.0000000	0.0000000
63	6.000000	1.664712	0.0000000	0.0000000
64	11.00000	2.914084	0.0000000	0.0000000
65	8.000000	1.964643	0.0000000	0.0000000
66	5.000000	1.181200	0.0000000	0.0000000
67	8.000000	1.624669	0.0000000	0.0000000
68	13.00000	2.354249	0.0000000	0.0000000
69	8.000000	1.357715	0.0000000	0.0000000
70	4.000000	0.6919813	0.0000000	0.0000000
71	7.000000	1.226721	0.0000000	0.0000000
72	7.000000	1.236862	0.0000000	0.0000000
73	8.000000	1.356260	0.0000000	0.0000000
74	7.000000	1.278657	0.0000000	0.0000000
75	2.000000	0.3688223	0.0000000	0.0000000
76	2.000000	0.3579354	0.0000000	0.0000000
77	3.000000	0.5171662	0.0000000	0.0000000
78	4.000000	0.6631582	0.0000000	0.0000000
79	5.000000	0.7462328	0.0000000	0.0000000
80	0.0000000	0.0000000	1.000000	1.000000
81	4.000000	0.6087087	1.000000	2.000000
82	3.000000	0.4658267	1.000000	3.000000
83	4.000000	0.6015934	1.000000	4.000000
84	1.000000	0.1344358	1.000000	5.000000
85	4.000000	0.5033070	1.000000	6.000000
86	1.000000	0.1068729	1.000000	7.000000
87	4.000000	0.4119040	1.000000	8.000000

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE
(continued)

YEAR	ACC	ACCRATE	D	TIMEDUM	HOURS
61.00000	66	18.05991	0.00	0.00	3654503.
62.00000	47	13.46252	0.00	0.00	3491174.
63.00000	54	14.98240	0.00	0.00	3604228.
64.00000	59	15.63009	0.00	0.00	3774771.
65.00000	65	15.96272	0.00	0.00	4071987.
66.00000	56	13.22944	0.00	0.00	4232982.
67.00000	54	10.96652	0.00	0.00	4924080.
68.00000	56	10.14138	0.00	0.00	5521931.
69.00000	51	8.655431	0.00	0.00	5892254.
70.00000	43	7.438799	0.00	0.00	5780503.
71.00000	43	7.535571	0.00	0.00	5706270.
72.00000	46	8.127948	0.00	0.00	5659485.
73.00000	36	6.103169	0.00	0.00	5898575.
74.00000	43	7.854606	0.00	0.00	5474495.
75.00000	30	5.532335	0.00	0.00	5422665.
76.00000	22	3.937289	0.00	0.00	5587601.
77.00000	20	3.447775	0.00	0.00	5800843.
78.00000	20	3.315791	0.00	0.00	6031743.
79.00000	23	3.432671	0.00	0.00	6700322.
80.00000	15	2.206668	1.0	1.0	6797578.
81.00000	25	3.804429	1.0	2.0	6571288.
82.00000	15	2.329134	1.0	3.0	6440163.
83.00000	22	3.308764	1.0	4.0	6649009.
84.00000	12	1.613229	1.0	5.0	7438497.
85.00000	17	2.139055	1.0	6.0	7947435.
86.00000	20	2.137459	1.0	7.0	9356906.
87.00000	30	3.089280	1.0	8.0	9711000.

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE
(continued)

```
REQUIRED MEMORY IS PAR=   10 CURRENT PAR=  500
 OLS ESTIMATION
      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTACCR
DURBIN-WATSON STATISTIC  =   1.56732
DURBIN-WATSON PROBABILITY =    0.058680
 R-SQUARE =   0.9282      R-SQUARE ADJUSTED =   0.9222
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.65967E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.25684
SUM OF SQUARED ERRORS-SSE=  1.5832
MEAN OF DEPENDENT VARIABLE =   2.5559
LOG OF THE LIKELIHOOD FUNCTION =-0.202451E-01
VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      24 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.12721     0.10382E-01  -12.253    -0.9285  -1.0962      -3.6829
D          0.34704     0.17709       1.9596     0.3714  0.17533      0.40230E-01
CONSTANT   11.867      0.72914       16.275     0.9576  0.00000       4.6427

REQUIRED MEMORY IS PAR=   10 CURRENT PAR=  500
 OLS ESTIMATION
      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTACCR
...NOTE..SAMPLE RANGE SET TO:     1,     27
DURBIN-WATSON STATISTIC  =   2.03626
DURBIN-WATSON PROBABILITY =    0.365287
R-SQUARE =   0.9535      R-SQUARE ADJUSTED =   0.9496
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.42751E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.20676
SUM OF SQUARED ERRORS-SSE=   1.0260
MEAN OF DEPENDENT VARIABLE =    2.5559
LOG OF THE LIKELIHOOD FUNCTION =  5.83556
VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      24 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.13709     0.78556E-02  -17.451    -0.9628  -1.1814      -3.9690
TIMEDUM    0.11084     0.25455E-01   4.3542     0.6643  0.29476      0.57819E-01
CONSTANT   12.553      0.55739       22.521     0.9771  0.00000       4.9112

      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTACCR
DURBIN-WATSON STATISTIC  =   2.00110
DURBIN-WATSON PROBABILITY =    0.269177
 R-SQUARE =   0.9539      R-SQUARE ADJUSTED =    0.9479
SUM OF SQUARED ERRORS-SSE=   1.0175
VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      23 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.13546     0.88098E-02  -15.376    -0.9546  -1.1673      -3.9219
D         -0.82706E-01 0.18835      -0.43912   -0.0912 -0.41783E-01 -0.95876E-02
TIMEDUM    0.12026     0.33629E-01   3.5760     0.5978  0.31982      0.62734E-01
CONSTANT   12.444      0.61857       20.118     0.9727  0.00000       4.8687
```

APPENDIX E

OLS USING THE SQUARE ROOT OF RATE
(continued)

```
REQUIRED MEMORY IS PAR=   10 CURRENT PAR=  500
 OLS ESTIMATION
      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTFATR
DURBIN-WATSON STATISTIC  =    2.10287
DURBIN-WATSON PROBABILITY =    0.449845
 R-SQUARE =    0.6602      R-SQUARE ADJUSTED =    0.6319
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.56895E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.23853
SUM OF SQUARED ERRORS-SSE=   1.3655
MEAN OF DEPENDENT VARIABLE =  0.93649
LOG OF THE LIKELIHOOD FUNCTION =   1.97709
VARIABLE    ESTIMATED    STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      24 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.36699E-01 0.96419E-02  -3.8062    -0.6135 -0.74092      -2.8999
D         -0.74544E-01 0.16447     -0.45325    -0.0921 -0.88229E-01 -0.23585E-01
CONSTANT   3.6743      0.67715      5.4262     0.7422  0.00000       3.9235

REQUIRED MEMORY IS PAR=   10 CURRENT PAR=  500
 OLS ESTIMATION
      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTFATR
...NOTE..SAMPLE RANGE SET TO:    1,    27
DURBIN-WATSON STATISTIC  =    2.26869
DURBIN-WATSON PROBABILITY =    0.608279
 R-SQUARE =    0.6714      R-SQUARE ADJUSTED =    0.6440
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.55030E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.23458
SUM OF SQUARED ERRORS-SSE=   1.3207
MEAN OF DEPENDENT VARIABLE =  0.93649
LOG OF THE LIKELIHOOD FUNCTION =   2.42714
VARIABLE    ESTIMATED    STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      24 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.47016E-01 0.89126E-02  -5.2752    -0.7328 -0.94920      -3.7151
TIMEDUM    0.29253E-01 0.28880E-01   1.0129     0.2025  0.18226       0.41649E-01
CONSTANT   4.3766      0.63239      6.9208     0.8162  0.00000       4.6734

      27 OBSERVATIONS      DEPENDENT VARIABLE = SQRTFATR
DURBIN-WATSON STATISTIC  =    2.12690
DURBIN-WATSON PROBABILITY =    0.390211
 R-SQUARE =    0.6997      R-SQUARE ADJUSTED =    0.6605
SUM OF SQUARED ERRORS-SSE=   1.2069
VARIABLE    ESTIMATED    STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      23 DF      CORR.  COEFFICIENT  AT MEANS
YEAR      -0.41068E-01 0.95949E-02  -4.2802    -0.6659 -0.82912      -3.2451
D         -0.30205     0.20513     -1.4724    -0.2935 -0.35750     -0.95564E-01
TIMEDUM    0.63663E-01 0.36626E-01   1.7382     0.3407  0.39665       0.90641E-01
CONSTANT   3.9801      0.67370      5.9079     0.7764  0.00000       4.2501
```

APPENDIX F

BOX COX PROCEDURE

APPENDIX F

BOX COX PROCEDURE

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controlable rate
genr  crate    =  ((1000000*y))/hours

* generate time since deregulation dummy
genr timedum   = d*(year - 79)
print  year y hours crate d timedum

box     crate   year                    /auto
box     crate   year   d                /auto
box     crate   year        timedum     /auto
box     crate   year   d    timedum     /auto

delete  / all
```

APPENDIX F

BOX COX PROCEDURE
(continued)

```
FILE 11  d:\shazam\d\f1\fatacc.doc
sample 1 27
read(11) year fatal acc hours

* generate fatal accident rate
genr  fatrate    =  (1000000*(fatal + .5))/hours

* generate accident rate
genr  accrate    =  (1000000*acc)/hours

* generate deregulation dummy
genr d   = dum(year - 79.9)

genr timedum   = d*(year - 79)

print year  fatal fatrate  hours acc accrate  d timedum

box     accrate   year                    /auto
box     accrate   year                    /auto
box     accrate   year        timedum     /auto
box     accrate   year   d    timedum     /auto

box     fatrate   year                    /auto
box     fatrate   year                    /auto
box     fatrate   year        timedum     /auto
box     fatrate   year   d    timedum     /auto

delete  / all
```

APPENDIX F

BOX COX PROCEDURE
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

YEAR	Y	HOURS	CRATE	D	TIMEDUM
64.	64	2441185.	26.21678	0.00	0.00
65.	45	2691129.	16.72161	0.00	0.00
66.	45	2819170.	15.96214	0.00	0.00
67.	48	3507054.	13.68670	0.00	0.00
68.	43	4015838.	10.70760	0.00	0.00
69.	44	4336713.	10.14593	0.00	0.00
70.	44	4294706.	10.24517	0.00	0.00
71.	48	4224634.	11.36193	0.00	0.00
72.	40	4204233.	9.514221	0.00	0.00
73.	30	4346571.	6.901992	0.00	0.00
74.	34	3997587.	8.505131	0.00	0.00
75.	36	3936489.	9.145205	0.00	0.00
76.	14	4024069.	3.479066	0.00	0.00
77.	20	4135728.	4.835908	0.00	0.00
78.	20	4166439.	4.800262	0.00	0.00
79.	14	4329449.	3.233668	0.00	0.00
80.	9.	4439343.	2.027327	1.0	1.0
81.	27	4049954.	6.666742	1.0	2.0
82.	15	4016962.	3.734165	1.0	3.0
83.	32	4197657.	7.623300	1.0	4.0
84.	24	4547810.	5.277265	1.0	5.0
85.	25	4744502.	5.269257	1.0	6.0
86.	26	5389885.	4.823851	1.0	7.0
87.	36	6921046.	5.201526	1.0	8.0
88.	33	7166746.	4.604600	1.0	9.0

APPENDIX F

BOX COX PROCEDURE
(continued)

DEPENDENT VARIABLE =CRATE
R-SQUARE = 0.7047 R-SQUARE ADJUSTED = 0.6918
SUM OF SQUARED ERRORS-SSE= 12.012
LOG OF THE LIKELIHOOD FUNCTION = -56.8449

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.14926	0.34136E-01	-4.3725	-0.6737	-0.84381	-5.0465
CONSTANT	14.476	2.6077	5.5512	0.7567	0.00000	6.4399

DEPENDENT VARIABLE =CRATE
R-SQUARE = 0.7188 R-SQUARE ADJUSTED = 0.6932
SUM OF SQUARED ERRORS-SSE= 11.440
LOG OF THE LIKELIHOOD FUNCTION = -56.1350

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.20026	0.42404E-01	-4.7227	-0.7095	-1.1321	-6.7709
D	1.0288	0.63117	1.6300	0.3283	0.38714	0.16476
CONSTANT	17.925	3.0453	5.8861	0.7821	0.00000	7.9742

DEPENDENT VARIABLE =CRATE
R-SQUARE = 0.8395 R-SQUARE ADJUSTED = 0.8249
SUM OF SQUARED ERRORS-SSE= 4.6345
LOG OF THE LIKELIHOOD FUNCTION = -48.7636

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.20955	0.18411E-01	-11.382	-0.9246	-1.4061	-8.4023
TIMEDUM	0.28760	0.46788E-01	6.1468	0.7950	0.76446	0.27312
CONSTANT	18.169	1.3351	13.608	0.9454	0.00000	9.5854

DEPENDENT VARIABLE =CRATE
R-SQUARE = 0.8458 R-SQUARE ADJUSTED = 0.8238
SUM OF SQUARED ERRORS-SSE= 5.2791
LOG OF THE LIKELIHOOD FUNCTION = -48.4371

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 21 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.23658	0.22537E-01	-10.497	-0.9165	-1.4576	-8.7108
D	0.29375	0.37295	0.78766	0.1694	0.12047	0.51233E-01
TIMEDUM	0.28813	0.58823E-01	4.8983	0.7303	0.70324	0.25126
CONSTANT	20.254	1.6149	12.542	0.9393	0.00000	9.8123

APPENDIX F

BOX COX PROCEDURE
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\fatacc.doc

4 VARIABLES AND 27 OBSERVATIONS STARTING AT OBS 1

YR	FATAL	FATRATE	HOURS	ACC	ACCRATE	D	TIMEDUM
61	6.0	1.778628	3654503.	66	18.05991	0.00	0.00
62	6.0	1.861838	3491174.	47	13.46252	0.00	0.00
63	6.0	1.803438	3604228.	54	14.98240	0.00	0.00
64	11.	3.046542	3774771.	59	15.63009	0.00	0.00
65	8.0	2.087433	4071987.	65	15.96272	0.00	0.00
66	5.0	1.299320	4232982.	56	13.22944	0.00	0.00
67	8.0	1.726211	4924080.	54	10.96652	0.00	0.00
68	13.	2.444797	5521931.	56	10.14138	0.00	0.00
69	8.0	1.442572	5892254.	51	8.655431	0.00	0.00
70	4.0	0.7784790	5780503.	43	7.438799	0.00	0.00
71	7.0	1.314344	5706270.	43	7.535571	0.00	0.00
72	7.0	1.325209	5659485.	46	8.127948	0.00	0.00
73	8.0	1.441026	5898575.	36	6.103169	0.00	0.00
74	7.0	1.369989	5474495.	43	7.854606	0.00	0.00
75	2.0	0.4610279	5422665.	30	5.532335	0.00	0.00
76	2.0	0.4474192	5587601.	22	3.937289	0.00	0.00
77	3.0	0.6033606	5800843.	20	3.447775	0.00	0.00
78	4.0	0.7460530	6031743.	20	3.315791	0.00	0.00
79	5.0	0.8208561	6700322.	23	3.432671	0.00	0.00
80	0.00	0.0735556	6797578.	15	2.206668	1.0	1.00
81	4.0	0.6847973	6571288.	25	3.804429	1.0	2.00
82	3.0	0.5434645	6440163.	15	2.329134	1.0	3.00
83	4.0	0.6767926	6649009.	22	3.308764	1.0	4.00
84	1.0	0.2016536	7438497.	12	1.613229	1.0	5.00
85	4.0	0.5662204	7947435.	17	2.139055	1.0	6.00
86	1.0	0.1603094	9356906.	20	2.137459	1.0	7.00
87	4.0	0.4633920	9711000.	30	3.089280	1.0	8.00

APPENDIX F

BOX COX PROCEDURE
(continued)

DEPENDENT VARIABLE =ACCRATE
R-SQUARE = 0.9238 R-SQUARE ADJUSTED = 0.9207
SUM OF SQUARED ERRORS-SSE= 2.6260
LOG OF THE L IKELIHOOD FUNCTION = -42.2704

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 25 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.13828	0.92394E-02	-14.966	-0.9485	-0.95357	-6.2147
CONSTANT	12.533	0.68759	18.228	0.9644	0.00000	7.6120

DEPENDENT VA RIABLE =ACCRATE
R-SQUARE = 0.9238 R-SQUARE ADJUSTED = 0.9207
SUM OF SQUAR ED ERRORS-SSE= 2.6260
LOG OF THE LIKELIHOOD FUNCTION = -42.2704

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 25 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0 .13828	0.92394E-02	-14.966	-0.9485	-0.95357	-6.2147
CONSTANT	12.533	0.68759	18.228	0.9644	0.00000	7.6120

DEPENDENT VARIABLE =ACCRATE
R-SQUARE = 0.9534 R-SQUARE ADJUSTED = 0.9496
SUM OF SQUARED ERRORS-SSE= 3.9523
LOG OF THE LIKELIHOOD FUNCTION = -36.4489

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 24 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.26838	0.14755E-01	-18.189	-0.9656	-1.1789	-7.4732
TIMEDUM	0.21412	0.47954E-01	4.4652	0.6736	0.29026	0.10743
CONSTANT	22.646	1.0471	21.627	0.9753	0.00000	8.5214

DEPENDENT VARIABLE =ACCRATE
R-SQUARE = 0.9535 R-SQUARE ADJUSTED = 0.9474
SUM OF SQUARED ERRORS-SSE= 3.6556
LOG OF THE LIKELIHOOD FUNCTION = -36.3395

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.25442	0.16153E-01	-15.750	-0.9566	-1.1613	-7.3729
D	-0.16109	0.34847	-0.46227	-0.0959	-0.43105E-01	-0.18691E-01
TIMEDUM	0.22131	0.62021E-01	3.5684	0.5969	0.31174	0.11556
CONSTANT	21.574	1.1342	19.022	0.9697	0.00000	8.4485

APPENDIX F

BOX COX PROCEDURE
(continued)

DEPENDENT VARIABLE =FATRATE
R-SQUARE = 0.7110 R-SQUARE ADJUSTED = 0.6994
SUM OF SQUARED ERRORS-SSE= 4.0117
LOG OF THE LIKELIHOOD FUNCTION = -10.3931

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 25 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.77985E-01	0.92406E-02	-8.4394	-0.8603	-0.84713	-5.4413
CONSTANT	5.7669	0.68754	8.3877	0.8590	0.00000	5.4375

DEPENDENT VARIABLE =FATRATE
R-SQUARE = 0.7110 R-SQUARE ADJUSTED = 0.6994
SUM OF SQUARED ERRORS-SSE= 4.0117
LOG OF THE LIKELIHOOD FUNCTION = -10.3931

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 25 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.77985E-01	0.92406E-02	-8.4394	-0.8603	-0.84713	-5.4413
CONSTANT	5.7669	0.68754	8.3877	0.8590	0.00000	5.4375

DEPENDENT VARIABLE =FATRATE
R-SQUARE = 0.7262 R-SQUARE ADJUSTED = 0.7034
SUM OF SQUARED ERRORS-SSE= 3.7783
LOG OF THE LIKELIHOOD FUNCTION = -9.72613

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 24 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.89832E-01	0.13717E-01	-6.5487	-0.8007	-0.97869	-6.2470
TIMEDUM	0.50862E-01	0.44728E-01	1.1371	0.2261	0.17101	0.63730E-01
CONSTANT	6.5849	0.97370	6.7627	0.8098	0.00000	6.1881

DEPENDENT VARIABLE =FATRATE
R-SQUARE = 0.7335 R-SQUARE ADJUSTED = 0.6987
SUM OF SQUARED ERRORS-SSE= 3.6999
LOG OF THE LIKELIHOOD FUNCTION = -9.30013

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.83288E-01	0.15861E-01	-5.2511	-0.7384	-0.90473	-5.8113
D	-0.31217	0.34423	-0.90688	-0.1858	-0.19880	-0.87213E-01
TIMEDUM	0.85181E-01	0.61147E-01	1.3931	0.2789	0.28555	0.10709
CONSTANT	6.1390	1.1136	5.5126	0.7545	0.00000	5.7884

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\agr.doc
sample 1 200
read(11) airline year d totocc y n u hours


* generate controllable rate
genr  ocrate     =  (1000000*(y+1))/hours


* generate log of the controllable rate
genr  lnocrate  =  log(ocrate)


*generate time since deregulation dummy
genr  timedum   =  d*(year - 79)


print year  ocrate lnocrate d timedum


pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year    timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  / all
```

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\agr.doc

8 VARIABLES AND 200 OBSERVATIONS STARTING AT OBS 1

YEAR	OCRATE	LNOCRATE	D	TIMEDUM
64.00000	22.01207	3.091591	0.0000000	0.0000000
65.00000	22.98716	3.134936	0.0000000	0.0000000
66.00000	17.65019	2.870746	0.0000000	0.0000000
67.00000	7.392663	2.000488	0.0000000	0.0000000
68.00000	11.31496	2.426126	0.0000000	0.0000000
69.00000	3.138102	1.143618	0.0000000	0.0000000
70.00000	10.41702	2.343441	0.0000000	0.0000000
71.00000	16.69885	2.815340	0.0000000	0.0000000
72.00000	7.781968	2.051809	0.0000000	0.0000000
73.00000	12.10068	2.493261	0.0000000	0.0000000
74.00000	11.39848	2.433480	0.0000000	0.0000000
75.00000	11.11245	2.408066	0.0000000	0.0000000
76.00000	6.096539	1.807721	0.0000000	0.0000000
77.00000	7.445573	2.007620	0.0000000	0.0000000
78.00000	7.264749	1.983034	0.0000000	0.0000000
79.00000	6.686745	1.900127	0.0000000	0.0000000
80.00000	1.441745	0.3658541	1.000000	1.000000
81.00000	6.552350	1.879824	1.000000	2.000000
82.00000	6.459635	1.865573	1.000000	3.000000
83.00000	10.62232	2.362957	1.000000	4.000000
84.00000	8.001526	2.079632	1.000000	5.000000
85.00000	11.64321	2.454723	1.000000	6.000000
86.00000	5.285088	1.664889	1.000000	7.000000
87.00000	5.989992	1.790090	1.000000	8.000000
88.00000	7.479348	2.012146	1.000000	9.000000
64.00000	12.88959	2.556420	0.0000000	0.0000000
65.00000	32.24316	3.473306	0.0000000	0.0000000
66.00000	26.02021	3.258874	0.0000000	0.0000000
67.00000	14.77443	2.692898	0.0000000	0.0000000
68.00000	5.981112	1.788606	0.0000000	0.0000000
69.00000	10.28315	2.330506	0.0000000	0.0000000
70.00000	10.27053	2.329278	0.0000000	0.0000000
71.00000	15.03774	2.710563	0.0000000	0.0000000
72.00000	10.20710	2.323084	0.0000000	0.0000000
73.00000	5.471238	1.699505	0.0000000	0.0000000
74.00000	5.936691	1.781152	0.0000000	0.0000000
75.00000	17.07262	2.837476	0.0000000	0.0000000
76.00000	24.46603	3.197286	0.0000000	0.0000000

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE
(continued)

77.00000	10.72421	2.372503	0.0000000	0.0000000
78.00000	9.499157	2.251203	0.0000000	0.0000000
79.00000	8.305579	2.116927	0.0000000	0.0000000
80.00000	10.06994	2.309554	1.000000	1.000000
81.00000	14.96394	2.705643	1.000000	2.000000
82.00000	12.96143	2.561978	1.000000	3.000000
83.00000	29.00208	3.367368	1.000000	4.000000
84.00000	7.688789	2.039763	1.000000	5.000000
85.00000	2.663669	0.9797046	1.000000	6.000000
86.00000	6.079680	1.804952	1.000000	7.000000
87.00000	6.251009	1.832743	1.000000	8.000000
88.00000	3.100160	1.131454	1.000000	9.000000
64.00000	27.83951	3.326456	0.0000000	0.0000000
65.00000	8.581592	2.149619	0.0000000	0.0000000
66.00000	30.35834	3.413071	0.0000000	0.0000000
67.00000	13.84682	2.628056	0.0000000	0.0000000
68.00000	9.389701	2.239613	0.0000000	0.0000000
69.00000	26.76509	3.287098	0.0000000	0.0000000
70.00000	9.454924	2.246536	0.0000000	0.0000000
71.00000	11.60699	2.451607	0.0000000	0.0000000
72.00000	18.56459	2.921256	0.0000000	0.0000000
73.00000	14.28117	2.658942	0.0000000	0.0000000
74.00000	15.70913	2.754242	0.0000000	0.0000000
75.00000	13.66038	2.614499	0.0000000	0.0000000
76.00000	9.328863	2.233113	0.0000000	0.0000000
77.00000	7.159221	1.968401	0.0000000	0.0000000
78.00000	8.313782	2.117915	0.0000000	0.0000000
79.00000	3.115066	1.136250	0.0000000	0.0000000
80.00000	4.534688	1.511756	1.000000	1.000000
81.00000	6.011133	1.793613	1.000000	2.000000
82.00000	1.539684	0.4315771	1.000000	3.000000
83.00000	1.501281	0.4063185	1.000000	4.000000
84.00000	4.246753	1.446155	1.000000	5.000000
85.00000	10.80516	2.380024	1.000000	6.000000
86.00000	2.693820	0.9909604	1.000000	7.000000
87.00000	6.576580	1.883515	1.000000	8.000000
88.00000	5.842311	1.765126	1.000000	9.000000
64.00000	44.68198	3.799570	0.0000000	0.0000000
65.00000	31.12773	3.438099	0.0000000	0.0000000
66.00000	30.09897	3.404491	0.0000000	0.0000000
67.00000	24.68851	3.206338	0.0000000	0.0000000
68.00000	14.65736	2.684942	0.0000000	0.0000000
69.00000	17.95441	2.887836	0.0000000	0.0000000
70.00000	9.602381	2.262011	0.0000000	0.0000000
71.00000	9.422865	2.243139	0.0000000	0.0000000

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE
(continued)

72.00000	15.30725	2.728327	0.0000000	0.0000000
73.00000	11.69064	2.458789	0.0000000	0.0000000
74.00000	9.988364	2.301421	0.0000000	0.0000000
75.00000	12.47900	2.524047	0.0000000	0.0000000
76.00000	6.016594	1.794521	0.0000000	0.0000000
77.00000	7.342737	1.993712	0.0000000	0.0000000
78.00000	5.779328	1.754287	0.0000000	0.0000000
79.00000	4.132283	1.418830	0.0000000	0.0000000
80.00000	4.066909	1.402883	1.000000	1.000000
81.00000	11.23619	2.419140	1.000000	2.000000
82.00000	5.869647	1.769794	1.000000	3.000000
83.00000	7.022531	1.949124	1.000000	4.000000
84.00000	6.491441	1.870485	1.000000	5.000000
85.00000	6.345814	1.847795	1.000000	6.000000
86.00000	11.05964	2.403302	1.000000	7.000000
87.00000	10.16819	2.319265	1.000000	8.000000
88.00000	6.005925	1.792746	1.000000	9.000000
64.00000	40.55123	3.702566	0.0000000	0.0000000
65.00000	17.60212	2.868019	0.0000000	0.0000000
66.00000	5.344021	1.675978	0.0000000	0.0000000
67.00000	7.978776	2.076785	0.0000000	0.0000000
68.00000	17.45981	2.859902	0.0000000	0.0000000
69.00000	3.128911	1.140685	0.0000000	0.0000000
70.00000	9.782534	2.280599	0.0000000	0.0000000
71.00000	27.90190	3.328695	0.0000000	0.0000000
72.00000	25.56760	3.241326	0.0000000	0.0000000
73.00000	11.26888	2.422045	0.0000000	0.0000000
74.00000	7.854812	2.061126	0.0000000	0.0000000
75.00000	8.077642	2.089100	0.0000000	0.0000000
76.00000	3.897131	1.360241	0.0000000	0.0000000
77.00000	7.634171	2.032634	0.0000000	0.0000000
78.00000	6.468975	1.867018	0.0000000	0.0000000
79.00000	3.748927	1.321470	0.0000000	0.0000000
80.00000	3.634210	1.290392	1.000000	1.000000
81.00000	22.00640	3.091333	1.000000	2.000000
82.00000	3.728297	1.315951	1.000000	3.000000
83.00000	6.652895	1.895052	1.000000	4.000000
84.00000	12.48120	2.524224	1.000000	5.000000
85.00000	8.400538	2.128296	1.000000	6.000000
86.00000	3.935451	1.370025	1.000000	7.000000
87.00000	4.787633	1.566036	1.000000	8.000000
88.00000	9.708090	2.272960	1.000000	9.000000
64.00000	31.27259	3.442742	0.0000000	0.0000000
65.00000	18.69176	2.928083	0.0000000	0.0000000
66.00000	12.96284	2.562087	0.0000000	0.0000000

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE (continued)

67.00000	14.99116	2.707460	0.0000000	0.0000000
68.00000	13.09140	2.571956	0.0000000	0.0000000
69.00000	14.78948	2.693916	0.0000000	0.0000000
70.00000	20.60000	3.025291	0.0000000	0.0000000
71.00000	15.30633	2.728267	0.0000000	0.0000000
72.00000	6.702188	1.902434	0.0000000	0.0000000
73.00000	6.365615	1.850911	0.0000000	0.0000000
74.00000	11.98863	2.483958	0.0000000	0.0000000
75.00000	8.251506	2.110396	0.0000000	0.0000000
76.00000	3.055796	1.117040	0.0000000	0.0000000
77.00000	6.468473	1.866940	0.0000000	0.0000000
78.00000	6.824844	1.920569	0.0000000	0.0000000
79.00000	13.68466	2.616276	0.0000000	0.0000000
80.00000	2.274956	0.8219606	1.000000	1.000000
81.00000	10.03731	2.306310	1.000000	2.000000
82.00000	7.313987	1.989789	1.000000	3.000000
83.00000	8.030322	2.083225	1.000000	4.000000
84.00000	5.650500	1.731744	1.000000	5.000000
85.00000	3.013065	1.102958	1.000000	6.000000
86.00000	10.49670	2.351061	1.000000	7.000000
87.00000	9.596008	2.261347	1.000000	8.000000
88.00000	8.235943	2.108508	1.000000	9.000000
64.00000	25.80416	3.250536	0.0000000	0.0000000
65.00000	17.35728	2.854012	0.0000000	0.0000000
66.00000	12.13560	2.496143	0.0000000	0.0000000
67.00000	13.23271	2.582692	0.0000000	0.0000000
68.00000	9.653721	2.267343	0.0000000	0.0000000
69.00000	11.52158	2.444222	0.0000000	0.0000000
70.00000	12.78667	2.548403	0.0000000	0.0000000
71.00000	8.893764	2.185350	0.0000000	0.0000000
72.00000	13.35292	2.591735	0.0000000	0.0000000
73.00000	4.899095	1.589050	0.0000000	0.0000000
74.00000	13.00896	2.565638	0.0000000	0.0000000
75.00000	13.38540	2.594165	0.0000000	0.0000000
76.00000	1.644672	0.4975409	0.0000000	0.0000000
77.00000	4.860000	1.581038	0.0000000	0.0000000
78.00000	3.333294	1.203961	0.0000000	0.0000000
79.00000	5.006684	1.610774	0.0000000	0.0000000
80.00000	3.904191	1.362051	1.000000	1.000000
81.00000	4.629062	1.532354	1.000000	2.000000
82.00000	10.08265	2.310816	1.000000	3.000000
83.00000	14.56611	2.678698	1.000000	4.000000
84.00000	4.533770	1.511554	1.000000	5.000000
85.00000	4.288532	1.455945	1.000000	6.000000
86.00000	8.360435	2.123510	1.000000	7.000000

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE
(continued)

87.00000	5.259633	1.660061	1.000000	8.000000
88.00000	3.291211	1.191256	1.000000	9.000000
64.00000	25.11452	3.223446	0.0000000	0.0000000
65.00000	15.12511	2.716357	0.0000000	0.0000000
66.00000	18.84458	2.936225	0.0000000	0.0000000
67.00000	22.24755	3.102232	0.0000000	0.0000000
68.00000	15.18275	2.720160	0.0000000	0.0000000
69.00000	10.37631	2.339525	0.0000000	0.0000000
70.00000	12.16605	2.498650	0.0000000	0.0000000
71.00000	12.00810	2.485582	0.0000000	0.0000000
72.00000	5.491392	1.703182	0.0000000	0.0000000
73.00000	4.403681	1.482441	0.0000000	0.0000000
74.00000	6.109295	1.809811	0.0000000	0.0000000
75.00000	7.807376	2.055069	0.0000000	0.0000000
76.00000	2.463667	0.9016509	0.0000000	0.0000000
77.00000	5.885309	1.772459	0.0000000	0.0000000
78.00000	7.555577	2.022286	0.0000000	0.0000000
79.00000	2.455111	0.8981721	0.0000000	0.0000000
80.00000	4.343586	1.468700	1.000000	1.000000
81.00000	5.274449	1.662874	1.000000	2.000000
82.00000	3.946294	1.372777	1.000000	3.000000
83.00000	10.80312	2.379835	1.000000	4.000000
84.00000	8.460237	2.135377	1.000000	5.000000
85.00000	3.629615	1.289127	1.000000	6.000000
86.00000	5.348924	1.676895	1.000000	7.000000
87.00000	4.906222	1.590504	1.000000	8.000000
88.00000	3.328111	1.202405	1.000000	9.000000

APPENDIX G

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE (continued)

POOLED CROSS-SECTION TIME-SERIES ESTIMATION
8 CROSS-SECTIONS AND 25 TIME-PERIODS
DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
SUM OF SQUARED ERRORS-SSE= 183.93
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.3046 BUSE RAW-MOMENT R-SQUARE = 0.9277
SUM OF SQUARED ERRORS-SSE= 175.84
LOG OF THE LIKELIHOOD FUNCTION = -147.425

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.74237E-01	0.10138E-01	-7.3227	-0.4626	-0.80459	-2.6092
D	0.38916	0.15032	2.5889	0.1814	0.28075	0.64789E-01
CONSTANT	7.6548	0.72833	10.510	0.5994	0.00000	3.5400

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.4021 BUSE RAW-MOMENT R-SQUARE = 0.9431
SUM OF SQUARED ERRORS-SSE= 175.58
LOG OF THE LIKELIHOOD FUNCTION = -139.342

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.93619E-01	0.91204E-02	-10.265	-0.5903	-1.0147	-3.2904
TIMEDUM	0.12246	0.22893E-01	5.3490	0.3561	0.52575	0.10194
CONSTANT	9.0477	0.66061	13.696	0.6984	0.00000	4.1842

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.4054 BUSE RAW-MOMENT R-SQUARE = 0.9438
SUM OF SQUARED ERRORS-SSE= 167.57
LOG OF THE LIKELIHOOD FUNCTION = -139.202

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.96067E-01	0.10142E-01	-9.4726	-0.5604	-1.0412	-3.3764
D	0.84415E-01	0.15607	0.54089	0.0386	0.60900E-01	0.14054E-01
TIMEDUM	0.11606	0.26028E-01	4.4589	0.3035	0.49828	0.96609E-01
CONSTANT	9.2142	0.72703	12.674	0.6711	0.00000	4.2612

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE WITH ZERO DUMMY

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE WITH ZERO DUMMY COMMAND FILE

```
FILE 11  d:\shazam\d\f1\agrzd.doc
sample 1 125
read(11) airline year d totocc y n u hours


* generate controlable rate
genr  crate     =  ((1000000*y))/hours

* generate zero dummy for crate = 0
genr  zerodum   =  dum (.001 - crate)

* generate modified rate with ones where there were zeroes
genr  modcrate  =  crate + zerodum

* generate log of the modified rate
genr  lnmodrat  =  log(modcrate)

* generate time since deregulation dummy
genr  timedum   =  d * (year - 79)


print year  crate zerodum modcrate lnmodrat d


pool lnmodrat year zerodum                 /ncross=5
pool lnmodrat year zerodum  d              /ncross=5
pool lnmodrat year zerodum     timedum     /ncross=5
pool lnmodrat year zerodum  d  timedum     /ncross=5

delete  / all
```

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE WITH ZERO DUMMY
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\agrzd.doc

8 VARIABLES AND 125 OBSERVATIONS STARTING AT OBS 1

YR	CRATE	ZERODUM	MODCRATE	LNMODRAT	D
64	19.26056	0.00	19.26056	2.958059	0.00
65	20.43303	0.00	20.43303	3.017153	0.00
66	15.44391	0.00	15.44391	2.737215	0.00
67	5.544497	0.00	5.544497	1.712806	0.00
68	9.698537	0.00	9.698537	2.271975	0.00
69	1.569051	0.00	1.569051	0.4504708	0.00
70	8.928877	0.00	8.928877	2.189291	0.00
71	15.18077	0.00	15.18077	2.720030	0.00
72	6.225574	0.00	6.225574	1.828666	0.00
73	10.58809	0.00	10.58809	2.359730	0.00
74	9.770125	0.00	9.770125	2.279329	0.00
75	9.524959	0.00	9.524959	2.253916	0.00
76	4.572404	0.00	4.572404	1.520039	0.00
77	5.956458	0.00	5.956458	1.784476	0.00
78	5.811799	0.00	5.811799	1.759890	0.00
79	5.349396	0.00	5.349396	1.676984	0.00
80	0.0000000	1.0	1.000000	0.0000000	1.0
81	4.914263	0.00	4.914263	1.592142	1.0
82	4.844727	0.00	4.844727	1.577891	1.0
83	9.104842	0.00	9.104842	2.208806	1.0
84	6.667938	0.00	6.667938	1.897311	1.0
85	10.47889	0.00	10.47889	2.349362	1.0
86	4.228071	0.00	4.228071	1.441746	1.0
87	5.134278	0.00	5.134278	1.635939	1.0
88	6.731413	0.00	6.731413	1.906785	1.0
64	23.19960	0.00	23.19960	3.144135	0.00
65	4.290796	0.00	4.290796	1.456472	0.00
66	26.56355	0.00	26.56355	3.279540	0.00
67	10.38511	0.00	10.38511	2.340373	0.00
68	6.259801	0.00	6.259801	1.834148	0.00
69	24.08858	0.00	24.08858	3.181738	0.00
70	7.091193	0.00	7.091193	1.958854	0.00
71	9.285590	0.00	9.285590	2.228464	0.00
72	16.50185	0.00	16.50185	2.803473	0.00
73	12.49603	0.00	12.49603	2.525411	0.00
74	13.74549	0.00	13.74549	2.620711	0.00
75	11.70889	0.00	11.70889	2.460349	0.00
76	7.463090	0.00	7.463090	2.009970	0.00

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE WITH ZERO DUMMY
(continued)

77	5.369416	0.00	5.369416	1.680719	0.00
78	6.651026	0.00	6.651026	1.894771	0.00
79	1.557533	0.00	1.557533	0.4431031	0.00
80	3.023125	0.00	3.023125	1.106291	1.0
81	4.508349	0.00	4.508349	1.505931	1.0
82	0.0000000	1.0	1.000000	0.0000000	1.0
83	0.0000000	1.0	1.000000	0.0000000	1.0
84	2.831169	0.00	2.831169	1.040690	1.0
85	9.454515	0.00	9.454515	2.246492	1.0
86	1.346910	0.00	1.346910	0.2978132	1.0
87	5.637069	0.00	5.637069	1.729364	1.0
88	5.007695	0.00	5.007695	1.610976	1.0
64	42.19964	0.00	42.19964	3.742412	0.00
65	28.73329	0.00	28.73329	3.358056	0.00
66	27.36270	0.00	27.36270	3.309181	0.00
67	22.63114	0.00	22.63114	3.119327	0.00
68	12.82519	0.00	12.82519	2.551411	0.00
69	16.32219	0.00	16.32219	2.792525	0.00
70	8.001984	0.00	8.001984	2.079690	0.00
71	7.852388	0.00	7.852388	2.060818	0.00
72	13.77653	0.00	13.77653	2.622966	0.00
73	10.22931	0.00	10.22931	2.325257	0.00
74	8.323636	0.00	8.323636	2.119099	0.00
75	10.91913	0.00	10.91913	2.390516	0.00
76	4.512445	0.00	4.512445	1.506839	0.00
77	5.874190	0.00	5.874190	1.770568	0.00
78	4.334496	0.00	4.334496	1.466605	0.00
79	2.754855	0.00	2.754855	1.013365	0.00
80	2.711273	0.00	2.711273	0.9974181	1.0
81	9.831668	0.00	9.831668	2.285609	1.0
82	4.402235	0.00	4.402235	1.482112	1.0
83	5.618025	0.00	5.618025	1.725980	1.0
84	5.193153	0.00	5.193153	1.647341	1.0
85	5.076651	0.00	5.076651	1.624652	1.0
86	9.830788	0.00	9.830788	2.285519	1.0
87	8.897170	0.00	8.897170	2.185733	1.0
88	4.504444	0.00	4.504444	1.505064	1.0
64	22.93703	0.00	22.93703	3.132753	0.00
65	14.87767	0.00	14.87767	2.699861	0.00
66	9.708479	0.00	9.708479	2.273000	0.00
67	11.34233	0.00	11.34233	2.428541	0.00
68	8.044768	0.00	8.044768	2.085022	0.00
69	10.08139	0.00	10.08139	2.310691	0.00
70	11.36593	0.00	11.36593	2.430620	0.00
71	7.411470	0.00	7.411470	2.003029	0.00

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE WITH ZERO DUMMY
(continued)

72	11.86926	0.00	11.86926	2.473952	0.00
73	3.266063	0.00	3.266063	1.183585	0.00
74	11.38284	0.00	11.38284	2.432107	0.00
75	11.71223	0.00	11.71223	2.460633	0.00
76	0.0000000	1.0	1.000000	0.0000000	0.00
77	3.240000	0.00	3.240000	1.175573	0.00
78	1.666647	0.00	1.666647	0.5108140	0.00
79	3.337789	0.00	3.337789	1.205309	0.00
80	1.952096	0.00	1.952096	0.6689034	1.0
81	2.314531	0.00	2.314531	0.8392070	1.0
82	7.561989	0.00	7.561989	2.023134	1.0
83	12.13843	0.00	12.13843	2.496376	1.0
84	2.266885	0.00	2.266885	0.8184066	1.0
85	2.144266	0.00	2.144266	0.7627974	1.0
86	6.270326	0.00	6.270326	1.835828	1.0
87	3.506422	0.00	3.506422	1.254596	1.0
88	1.645606	0.00	1.645606	0.4981085	1.0
64	23.44022	0.00	23.44022	3.154453	0.00
65	13.61260	0.00	13.61260	2.610996	0.00
66	17.27419	0.00	17.27419	2.849214	0.00
67	21.01157	0.00	21.01157	3.045073	0.00
68	14.09827	0.00	14.09827	2.646052	0.00
69	9.338676	0.00	9.338676	2.234165	0.00
70	11.15222	0.00	11.15222	2.411638	0.00
71	10.91646	0.00	10.91646	2.390272	0.00
72	4.393113	0.00	4.393113	1.480038	0.00
73	3.302761	0.00	3.302761	1.194759	0.00
74	4.887436	0.00	4.887436	1.586668	0.00
75	6.506147	0.00	6.506147	1.872747	0.00
76	1.231834	0.00	1.231834	0.2085037	0.00
77	4.708248	0.00	4.708248	1.549316	0.00
78	6.476209	0.00	6.476209	1.868135	0.00
79	1.227556	0.00	1.227556	0.2050249	0.00
80	3.257690	0.00	3.257690	1.181018	1.0
81	3.955837	0.00	3.955837	1.375192	1.0
82	2.630862	0.00	2.630862	0.9673117	1.0
83	9.602769	0.00	9.602769	2.262052	1.0
84	7.402707	0.00	7.402707	2.001846	1.0
85	2.419743	0.00	2.419743	0.8836614	1.0
86	4.457436	0.00	4.457436	1.494574	1.0
87	4.088518	0.00	4.088518	1.408183	1.0
88	2.496083	0.00	2.496083	0.9147228	1.0

APPENDIX H

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE WITH ZERO DUMMY (continued)

POOLED CROSS-SECTION TIME-SERIES ESTIMATION
5 CROSS-SECTIONS AND 25 TIME-PERIODS
125 TOTAL OBSERVATIONS
DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.4813 BUSE RAW-MOMENT R-SQUARE = 0.8970
SUM OF SQUARED ERRORS-SSE= 109.94
LOG OF THE LIKELIHOOD FUNCTION = -101.360

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 122 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.63626E-01	0.82718E-02	-7.6919	-0.5715	-0.56733	-2.5909
ZERODUM	-1.6486	0.27019	-6.1016	-0.4835	-0.35878	-0.28266E-01
CONSTANT	6.7576	0.62971	10.731	0.6968	0.00000	3.6207

BUSE R-SQUARE = 0.4856 BUSE RAW-MOMENT R-SQUARE = 0.9013
SUM OF SQUARED ERRORS-SSE= 104.93
LOG OF THE LIKELIHOOD FUNCTION = -99.9352

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 121 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.86907E-01	0.13815E-01	-6.2908	-0.4964	-0.77492	-3.5389
ZERODUM	-1.7429	0.28721	-6.0684	-0.4830	-0.37930	-0.29883E-01
D	0.42132	0.20769	2.0286	0.1814	0.25006	0.81267E-01
CONSTANT	8.3713	0.99236	8.4358	0.6085	0.00000	4.4854

BUSE R-SQUARE = 0.5541 BUSE RAW-MOMENT R-SQUARE = 0.9208
SUM OF SQUARED ERRORS-SSE= 104.77
LOG OF THE LIKELIHOOD FUNCTION = -95.2710

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 121 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10857	0.12593E-01	-8.6219	-0.6169	-0.96811	-4.4212
ZERODUM	-1.5223	0.27464	-5.5428	-0.4500	-0.33129	-0.26101E-01
TIMEDUM	0.13126	0.31427E-01	4.1768	0.3550	0.46364	0.12659
CONSTANT	9.9248	0.91087	10.896	0.7037	0.00000	5.3177

BUSE R-SQUARE = 0.5535 BUSE RAW-MOMENT R-SQUARE = 0.9209
SUM OF SQUARED ERRORS-SSE= 99.747
LOG OF THE LIKELIHOOD FUNCTION = -95.1486

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 120 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11257	0.13972E-01	-8.0571	-0.5925	-1.0038	-4.5841
ZERODUM	-1.5522	0.28708	-5.4068	-0.4426	-0.33779	-0.26613E-01
D	0.11452	0.22232	0.51513	0.0470	0.67974E-01	0.22090E-01
TIMEDUM	0.12419	0.36636E-01	3.3897	0.2956	0.43865	0.11977
CONSTANT	10.200	1.0014	10.186	0.6809	0.00000	5.4651

APPENDIX I

OPERATING RATIO

APPENDIX I

OPERATING RATIO

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\opr.doc
sample 1 152
read(11) airline year d totocc y n u hours opratio

* generate controllable rate
genr  ocrate    =  (1000000*(y+1))/hours

* generate log of the controllable rate
genr  lnocrate  =  log(ocrate)

* generate time since deregulation dummy
genr  timedum   =  d*(year - 79)

print year  ocrate lnocrate d timedum opratio

pool lnocrate year  opratio              /ncross=8
pool lnocrate year  opratio  d           /ncross=8
pool lnocrate year  opratio    timedum   /ncross=8
pool lnocrate year  opratio  d timedum   /ncross=8

delete  / all

FILE 11  d:\shazam\d\f1\lopr.doc
sample 1 144
read(11) airline year d totocc y n u hours lagopr

* generate controllable rate
genr  ocrate    =  (1000000*(y+1))/hours

* generate log of the controllable rate
genr  lnocrate  =  log(ocrate)

* generate time since deregulation dummy
genr  timedum   =  d*(year - 79)

print year  ocrate lnocrate d timedum lagopr

pool lnocrate year  lagopr              /ncross=8
pool lnocrate year  lagopr  d           /ncross=8
pool lnocrate year  lagopr    timedum   /ncross=8
pool lnocrate year  lagopr  d timedum   /ncross=8
delete  / all
```

APPENDIX I

OPERATING RATIO
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\opr.doc

9 VARIABLES AND 152 OBSERVATIONS STARTING AT OBS 1

YR	OCRATE	LNOCRATE	D	TIMEDUM	OPRATIO
70	10.41702	2.343441	0.00	0.00	1.013336
71	16.69885	2.815340	0.00	0.00	0.9769582
72	7.781968	2.051809	0.00	0.00	0.9695126
73	12.10068	2.493261	0.00	0.00	1.024519
74	11.39848	2.433480	0.00	0.00	0.9761608
75	11.11245	2.408066	0.00	0.00	1.015878
76	6.096539	1.807721	0.00	0.00	0.9661233
77	7.445573	2.007620	0.00	0.00	0.9729827
78	7.264749	1.983034	0.00	0.00	0.9644798
79	6.686745	1.900127	0.00	0.00	0.9984729
80	1.441745	0.3658541	1.0	1.0	1.030660
81	6.552350	1.879824	1.0	2.0	0.9889147
82	6.459635	1.865573	1.0	3.0	1.004587
83	10.62232	2.362957	1.0	4.0	0.9449481
84	8.001526	2.079632	1.0	5.0	0.9333518
85	11.64321	2.454723	1.0	6.0	0.9135595
86	5.285088	1.664889	1.0	7.0	0.9330558
87	5.989992	1.790090	1.0	8.0	0.9335834
88	7.479348	2.012146	1.0	9.0	0.9063228
70	10.27053	2.329278	0.00	0.00	0.9301763
71	15.03774	2.710563	0.00	0.00	0.9084038
72	10.20710	2.323084	0.00	0.00	0.9064261
73	5.471238	1.699505	0.00	0.00	0.9607209
74	5.936691	1.781152	0.00	0.00	0.8977497
75	17.07262	2.837476	0.00	0.00	0.9343404
76	24.46603	3.197286	0.00	0.00	0.9318145
77	10.72421	2.372503	0.00	0.00	0.9319356
78	9.499157	2.251203	0.00	0.00	0.9446996
79	8.305579	2.116927	0.00	0.00	1.022308
80	10.06994	2.309554	1.0	1.0	1.062655
81	14.96394	2.705643	1.0	2.0	1.055547
82	12.96143	2.561978	1.0	3.0	1.050567
83	29.00208	3.367368	1.0	4.0	1.132921
84	7.688789	2.039763	1.0	5.0	0.9101411
85	2.663669	0.9797046	1.0	6.0	0.9101889
86	6.079680	1.804952	1.0	7.0	0.9302108
87	6.251009	1.832743	1.0	8.0	0.9932102
88	3.100160	1.131454	1.0	9.0	0.9827683
70	9.454924	2.246536	0.00	0.00	0.8780282
71	11.60699	2.451607	0.00	0.00	0.9103325

APPENDIX I

OPERATING RATIO
(continued)

72	18.56459	2.921256	0.00	0.00	0.8855433
73	14.28117	2.658942	0.00	0.00	0.8898662
74	15.70913	2.754242	0.00	0.00	0.8797147
75	13.66038	2.614499	0.00	0.00	0.9504106
76	9.328863	2.233113	0.00	0.00	0.9215828
77	7.159221	1.968401	0.00	0.00	0.9069057
78	8.313782	2.117915	0.00	0.00	0.9035657
79	3.115066	1.136250	0.00	0.00	0.9537052
80	4.534688	1.511756	1.0	1.0	0.9502776
81	6.011133	1.793613	1.0	2.0	0.9762623
82	1.539684	0.4315771	1.0	3.0	1.023665
83	1.501281	0.4063185	1.0	4.0	1.014649
84	4.246753	1.446155	1.0	5.0	0.9360994
85	10.80516	2.380024	1.0	6.0	0.9512033
86	2.693820	0.9909604	1.0	7.0	0.9499553
87	6.576580	1.883515	1.0	8.0	0.9287347
88	5.842311	1.765126	1.0	9.0	0.9290386
70	9.602381	2.262011	0.00	0.00	0.9548052
71	9.422865	2.243139	0.00	0.00	0.9659982
72	15.30725	2.728327	0.00	0.00	0.9542277
73	11.69064	2.458789	0.00	0.00	1.015489
74	9.988364	2.301421	0.00	0.00	0.9537769
75	12.47900	2.524047	0.00	0.00	0.9960571
76	6.016594	1.794521	0.00	0.00	0.9565586
77	7.342737	1.993712	0.00	0.00	0.9830934
78	5.779328	1.754287	0.00	0.00	0.9593276
79	4.132283	1.418830	0.00	0.00	0.9614558
80	4.066909	1.402883	1.0	1.0	0.9994623
81	11.23619	2.419140	1.0	2.0	1.013401
82	5.869647	1.769794	1.0	3.0	1.004983
83	7.022531	1.949124	1.0	4.0	1.025394
84	6.491441	1.870485	1.0	5.0	0.9565456
85	6.345814	1.847795	1.0	6.0	0.9539746
86	11.05964	2.403302	1.0	7.0	0.9856234
87	10.16819	2.319265	1.0	8.0	0.9869959
88	6.005925	1.792746	1.0	9.0	1.053866
70	9.782534	2.280599	0.00	0.00	0.8650809
71	27.90190	3.328695	0.00	0.00	0.9570119
72	25.56760	3.241326	0.00	0.00	0.9611554
73	11.26888	2.422045	0.00	0.00	0.9115769
74	7.854812	2.061126	0.00	0.00	0.8982241
75	8.077642	2.089100	0.00	0.00	0.9387390
76	3.897131	1.360241	0.00	0.00	0.8935346
77	7.634171	2.032634	0.00	0.00	0.8998075
78	6.468975	1.867018	0.00	0.00	0.9144751
79	3.748927	1.321470	0.00	0.00	0.9567365
80	3.634210	1.290392	1.0	1.0	1.014600

APPENDIX I

OPERATING RATIO
(continued)

81	22.00640	3.091333	1.0	2.0	0.9988829
82	3.728297	1.315951	1.0	3.0	1.004236
83	6.652895	1.895052	1.0	4.0	0.9686219
84	12.48120	2.524224	1.0	5.0	0.9606870
85	8.400538	2.128296	1.0	6.0	0.9712254
86	3.935451	1.370025	1.0	7.0	0.9583825
87	4.787633	1.566036	1.0	8.0	0.9595731
88	9.708090	2.272960	1.0	9.0	0.9649883
70	20.60000	3.025291	0.00	0.00	1.026581
71	15.30633	2.728267	0.00	0.00	1.013768
72	6.702188	1.902434	0.00	0.00	1.001487
73	6.365615	1.850911	0.00	0.00	1.001192
74	11.98863	2.483958	0.00	0.00	1.062088
75	8.251506	2.110396	0.00	0.00	1.020982
76	3.055796	1.117040	0.00	0.00	0.9917985
77	6.468473	1.866940	0.00	0.00	0.9542797
78	6.824844	1.920569	0.00	0.00	0.9370113
79	13.68466	2.616276	0.00	0.00	0.9720072
80	2.274956	0.8219606	1.0	1.0	1.035619
81	10.03731	2.306310	1.0	2.0	1.105263
82	7.313987	1.989789	1.0	3.0	1.107374
83	8.030322	2.083225	1.0	4.0	0.9962797
84	5.650500	1.731744	1.0	5.0	1.039986
85	3.013065	1.102958	1.0	6.0	1.065752
86	10.49670	2.351061	1.0	7.0	1.136255
87	9.596008	2.261347	1.0	8.0	1.054600
88	8.235943	2.108508	1.0	9.0	1.029308
70	12.78667	2.548403	0.00	0.00	1.073206
71	8.893764	2.185350	0.00	0.00	0.9880938
72	13.35292	2.591735	0.00	0.00	0.9470673
73	4.899095	1.589050	0.00	0.00	0.9522793
74	13.00896	2.565638	0.00	0.00	1.010386
75	13.38540	2.594165	0.00	0.00	1.045252
76	1.644672	0.4975409	0.00	0.00	0.9738675
77	4.860000	1.581038	0.00	0.00	0.9816897
78	3.333294	1.203961	0.00	0.00	0.9801738
79	5.006684	1.610774	0.00	0.00	1.015234
80	3.904191	1.362051	1.0	1.0	1.010865
81	4.629062	1.532354	1.0	2.0	0.9988842
82	10.08265	2.310816	1.0	3.0	1.032190
83	14.56611	2.678698	1.0	4.0	1.019582
84	4.533770	1.511554	1.0	5.0	0.9793932
85	4.288532	1.455945	1.0	6.0	1.016468
86	8.360435	2.123510	1.0	7.0	1.023801
87	5.259633	1.660061	1.0	8.0	0.9407275
88	3.291211	1.191256	1.0	9.0	0.9405159
70	12.16605	2.498650	0.00	0.00	1.013977

APPENDIX I

OPERATING RATIO
(continued)

71	12.00810	2.485582	0.00	0.00	0.9772700
72	5.491392	1.703182	0.00	0.00	0.9560165
73	4.403681	1.482441	0.00	0.00	0.9226813
74	6.109295	1.809811	0.00	0.00	0.9204581
75	7.807376	2.055069	0.00	0.00	1.002413
76	2.463667	0.9016509	0.00	0.00	0.9870916
77	5.885309	1.772459	0.00	0.00	0.9728370
78	7.555577	2.022286	0.00	0.00	0.9178491
79	2.455111	0.8981721	0.00	0.00	1.073398
80	4.343586	1.468700	1.0	1.0	1.015533
81	5.274449	1.662874	1.0	2.0	1.032823
82	3.946294	1.372777	1.0	3.0	1.014857
83	10.80312	2.379835	1.0	4.0	0.9711791
84	8.460237	2.135377	1.0	5.0	0.9097885
85	3.629615	1.289127	1.0	6.0	1.066666
86	5.348924	1.676895	1.0	7.0	1.001496
87	4.906222	1.590504	1.0	8.0	0.9807680
88	3.328111	1.202405	1.0	9.0	0.9239948

APPENDIX I

OPERATING RATIO
(continued)

POOLED CROSS-SECTION TIME-SERIES ESTIMATION
8 CROSS-SECTIONS AND 19 TIME-PERIODS
152 TOTAL OBSERVATIONS
DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.0894 BUSE RAW-MOMENT R-SQUARE = 0.9126
SUM OF SQUARED ERRORS-SSE= 127.91
LOG OF THE LIKELIHOOD FUNCTION = -111.560

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 149 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.34749E-01	0.90833E-02	-3.8256	-0.2991	-0.32752	-1.3859
OPRATIO	0.43557	0.86916	0.50114	0.0410	0.38967E-01	0.21473
CONSTANT	4.3062	1.0405	4.1385	0.3211	0.00000	2.1740

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.0995 BUSE RAW-MOMENT R-SQUARE = 0.9174
SUM OF SQUARED ERRORS-SSE= 119.91
LOG OF THE LIKELIHOOD FUNCTION = -111.077

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 148 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.49431E-01	0.16293E-01	-3.0339	-0.2420	-0.46590	-1.9715
OPRATIO	0.14604	0.88790	0.16448	0.0135	0.13065E-01	0.71995E-01
D	0.19647	0.18033	1.0895	0.0892	0.16881	0.46983E-01
CONSTANT	5.6563	1.5764	3.5880	0.2829	0.00000	2.8556

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2234 BUSE RAW-MOMENT R-SQUARE = 0.9451
SUM OF SQUARED ERRORS-SSE= 119.60
LOG OF THE LIKELIHOOD FUNCTION = -102.781

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 148 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10124	0.16219E-01	-6.2419	-0.4565	-0.95419	-4.0377
OPRATIO	0.50828	0.78862	0.64452	0.0529	0.45472E-01	0.25057
TIMEDUM	0.13604	0.28809E-01	4.7222	0.3619	0.71739	0.16267
CONSTANT	9.1719	1.3629	6.7295	0.4840	0.00000	4.6305

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2256 BUSE RAW-MOMENT R-SQUARE = 0.9453
SUM OF SQUARED ERRORS-SSE= 111.61
LOG OF THE LIKELIHOOD FUNCTION = -102.688

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 147 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10593	0.18790E-01	-5.6374	-0.4216	-0.99838	-4.2247
OPRATIO	0.40417	0.82072	0.49246	0.0406	0.36157E-01	0.19925
D	0.77962E-01	0.16211	0.48092	0.0396	0.66986E-01	0.18644E-01
TIMEDUM	0.13330	0.29463E-01	4.5244	0.3496	0.70294	0.15939
CONSTANT	9.6135	1.6331	5.8866	0.4368	0.00000	4.8534

APPENDIX I

OPERATING RATIO
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\lopr.doc

9 VARIABLES AND 144 OBSERVATIONS STARTING AT OBS 1

YEAR	OCRATE	LNOCRATE	D	TIMEDUM	LAGOPR
71	16.69885	2.815340	0.00	0.	1.013336
72	7.781968	2.051809	0.00	0.	0.9769582
73	12.10068	2.493261	0.00	0.	0.9695126
74	11.39848	2.433480	0.00	0.	1.024519
75	11.11245	2.408066	0.00	0.	0.9761608
76	6.096539	1.807721	0.00	0.	1.015878
77	7.445573	2.007620	0.00	0.	0.9661233
78	7.264749	1.983034	0.00	0.	0.9729827
79	6.686745	1.900127	0.00	0.	0.9644798
80	1.441745	0.3658541	1.0	1	0.9984729
81	6.552350	1.879824	1.0	2	1.030660
82	6.459635	1.865573	1.0	3	0.9889147
83	10.62232	2.362957	1.0	4	1.004587
84	8.001526	2.079632	1.0	5	0.9449481
85	11.64321	2.454723	1.0	6	0.9333518
86	5.285088	1.664889	1.0	7	0.9135595
87	5.989992	1.790090	1.0	8	0.9330558
88	7.479348	2.012146	1.0	9	0.9335834
71	15.03774	2.710563	0.00	0.	0.9301763
72	10.20710	2.323084	0.00	0.	0.9084038
73	5.471238	1.699505	0.00	0.	0.9064261
74	5.936691	1.781152	0.00	0.	0.9607209
75	17.07262	2.837476	0.00	0.	0.8977497
76	24.46603	3.197286	0.00	0.	0.9343404
77	10.72421	2.372503	0.00	0.	0.9318145
78	9.499157	2.251203	0.00	0.	0.9319356
79	8.305579	2.116927	0.00	0.	0.9446996
80	10.06994	2.309554	1.0	1	1.022308
81	14.96394	2.705643	1.0	2	1.062655
82	12.96143	2.561978	1.0	3	1.055547
83	29.00208	3.367368	1.0	4	1.050567
84	7.688789	2.039763	1.0	5	1.132921
85	2.663669	0.9797046	1.0	6	0.9101411
86	6.079680	1.804952	1.0	7	0.9101889
87	6.251009	1.832743	1.0	8	0.9302108
88	3.100160	1.131454	1.0	9	0.9932102
71	11.60699	2.451607	0.00	0.	0.8780282
72	18.56459	2.921256	0.00	0.	0.9103325
73	14.28117	2.658942	0.00	0.	0.8855433
74	15.70913	2.754242	0.00	0.	0.8898662
75	13.66038	2.614499	0.00	0.	0.8797147
76	9.328863	2.233113	0.00	0.	0.9504106

APPENDIX I

OPERATING RATIO
(continued)

77	7.159221	1.968401	0.00	0.	0.9215828
78	8.313782	2.117915	0.00	0.	0.9069057
79	3.115066	1.136250	0.00	0.	0.9035657
80	4.534688	1.511756	1.0	1	0.9537052
81	6.011133	1.793613	1.0	2	0.9502776
82	1.539684	0.4315771	1.0	3	0.9762623
83	1.501281	0.4063185	1.0	4	1.023665
84	4.246753	1.446155	1.0	5	1.014649
85	10.80516	2.380024	1.0	6	0.9360994
86	2.693820	0.9909604	1.0	7	0.9512033
87	6.576580	1.883515	1.0	8	0.9499553
88	5.842311	1.765126	1.0	9	0.9287347
71	9.422865	2.243139	0.00	0.	0.9548052
72	15.30725	2.728327	0.00	0.	0.9659982
73	11.69064	2.458789	0.00	0.	0.9542277
74	9.988364	2.301421	0.00	0.	1.015489
75	12.47900	2.524047	0.00	0.	0.9537769
76	6.016594	1.794521	0.00	0.	0.9960571
77	7.342737	1.993712	0.00	0.	0.9565586
78	5.779328	1.754287	0.00	0.	0.9830934
79	4.132283	1.418830	0.00	0.	0.9593276
80	4.066909	1.402883	1.0	1	0.9614558
81	11.23619	2.419140	1.0	2	0.9994623
82	5.869647	1.769794	1.0	3	1.013401
83	7.022531	1.949124	1.0	4	1.004983
84	6.491441	1.870485	1.0	5	1.025394
85	6.345814	1.847795	1.0	6	0.9565456
86	11.05964	2.403302	1.0	7	0.9539746
87	10.16819	2.319265	1.0	8	0.9856234
88	6.005925	1.792746	1.0	9	0.9869959
71	27.90190	3.328695	0.00	0.	0.8650809
72	25.56760	3.241326	0.00	0.	0.9570119
73	11.26888	2.422045	0.00	0.	0.9611554
74	7.854812	2.061126	0.00	0.	0.9115769
75	8.077642	2.089100	0.00	0.	0.8982241
76	3.897131	1.360241	0.00	0.	0.9387390
77	7.634171	2.032634	0.00	0.	0.8935346
78	6.468975	1.867018	0.00	0.	0.8998075
79	3.748927	1.321470	0.00	0.	0.9144751
80	3.634210	1.290392	1.0	1	0.9567365
81	22.00640	3.091333	1.0	2	1.014600
82	3.728297	1.315951	1.0	3	0.9988829
83	6.652895	1.895052	1.0	4	1.004236
84	12.48120	2.524224	1.0	5	0.9686219
85	8.400538	2.128296	1.0	6	0.9606870
86	3.935451	1.370025	1.0	7	0.9712254
87	4.787633	1.566036	1.0	8	0.9583825

APPENDIX I

OPERATING RATIO
(continued)

88	9.708090	2.272960	1.0	9	0.9595731
71	15.30633	2.728267	0.00	0.	1.026581
72	6.702188	1.902434	0.00	0.	1.013768
73	6.365615	1.850911	0.00	0.	1.001487
74	11.98863	2.483958	0.00	0.	1.001192
75	8.251506	2.110396	0.00	0.	1.062088
76	3.055796	1.117040	0.00	0.	1.020982
77	6.468473	1.866940	0.00	0.	0.9917985
78	6.824844	1.920569	0.00	0.	0.9542797
79	13.68466	2.616276	0.00	0.	0.9370113
80	2.274956	0.8219606	1.0	1	0.9720072
81	10.03731	2.306310	1.0	2	1.035619
82	7.313987	1.989789	1.0	3	1.105263
83	8.030322	2.083225	1.0	4	1.107374
84	5.650500	1.731744	1.0	5	0.9962797
85	3.013065	1.102958	1.0	6	1.039986
86	10.49670	2.351061	1.0	7	1.065752
87	9.596008	2.261347	1.0	8	1.136255
88	8.235943	2.108508	1.0	9	1.054600
71	8.893764	2.185350	0.00	0.	1.073206
72	13.35292	2.591735	0.00	0.	0.9880938
73	4.899095	1.589050	0.00	0.	0.9470673
74	13.00896	2.565638	0.00	0.	0.9522793
75	13.38540	2.594165	0.00	0.	1.010386
76	1.644672	0.4975409	0.00	0.	1.045252
77	4.860000	1.581038	0.00	0.	0.9738675
78	3.333294	1.203961	0.00	0.	0.9816897
79	5.006684	1.610774	0.00	0.	0.9801738
80	3.904191	1.362051	1.0	1	1.015234
81	4.629062	1.532354	1.0	2	1.010865
82	10.08265	2.310816	1.0	3	0.9988842
83	14.56611	2.678698	1.0	4	1.032190
84	4.533770	1.511554	1.0	5	1.019582
85	4.288532	1.455945	1.0	6	0.9793932
86	8.360435	2.123510	1.0	7	1.016468
87	5.259633	1.660061	1.0	8	1.023801
88	3.291211	1.191256	1.0	9	0.9407275
71	12.00810	2.485582	0.00	0.	1.013977
72	5.491392	1.703182	0.00	0.	0.9772700
73	4.403681	1.482441	0.00	0.	0.9560165
74	6.109295	1.809811	0.00	0.	0.9226813
75	7.807376	2.055069	0.00	0.	0.9204581
76	2.463667	0.9016509	0.00	0.	1.002413
77	5.885309	1.772459	0.00	0.	0.9870916
78	7.555577	2.022286	0.00	0.	0.9728370
79	2.455111	0.8981721	0.00	0.	0.9178491
80	4.343586	1.468700	1.0	1	1.073398

APPENDIX I

OPERATING RATIO
(continued)

81	5.274449	1.662874	1.0	2	1.015533
82	3.946294	1.372777	1.0	3	1.032823
83	10.80312	2.379835	1.0	4	1.014857
84	8.460237	2.135377	1.0	5	0.9711791
85	3.629615	1.289127	1.0	6	0.9097885
86	5.348924	1.676895	1.0	7	1.066666
87	4.906222	1.590504	1.0	8	1.001496
88	3.328111	1.202405	1.0	9	0.9807680

APPENDIX I

OPERATING RATIO (continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.0639   BUSE RAW-MOMENT R-SQUARE = 0.9122
SUM OF SQUARED ERRORS-SSE= 119.90
LOG OF THE LIKELIHOOD FUNCTION = -108.100

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 141 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.30378E-01	0.98058E-02	-3.0980	-0.2524	-0.27001	-1.2352
LAGOPR	0.31373	0.89691	0.34979	0.0294	0.27993E-01	0.15678
CONSTANT	4.0650	1.0783	3.7699	0.3026	0.00000	2.0791

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.0714   BUSE RAW-MOMENT R-SQUARE = 0.9151
SUM OF SQUARED ERRORS-SSE= 111.88
LOG OF THE LIKELIHOOD FUNCTION = -107.777

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 140 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.44329E-01	0.17929E-01	-2.4724	-0.2045	-0.39401	-1.8025
LAGOPR	0.24078E-01	0.94346	0.25521E-01	0.0022	0.21484E-02	0.12033E-01
D	0.17554	0.19009	0.92345	0.0778	0.15037	0.44892E-01
CONSTANT	5.3709	1.7510	3.0673	0.2509	0.00000	2.7470

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2075   BUSE RAW-MOMENT R-SQUARE = 0.9445
SUM OF SQUARED ERRORS-SSE= 111.51
LOG OF THE LIKELIHOOD FUNCTION = -99.4537

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 140 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10990	0.18670E-01	-5.8862	-0.4454	-0.97680	-4.4686
LAGOPR	0.56560E-01	0.83008	0.68138E-01	0.0058	0.50466E-02	0.28264E-01
TIMEDUM	0.14870	0.31214E-01	4.7639	0.3735	0.78865	0.19014
CONSTANT	10.287	1.5870	6.4823	0.4805	0.00000	5.2616

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2168   BUSE RAW-MOMENT R-SQUARE = 0.9461
SUM OF SQUARED ERRORS-SSE= 103.50
LOG OF THE LIKELIHOOD FUNCTION = -99.0964

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 139 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.12075	0.21893E-01	-5.5157	-0.4238	-1.0733	-4.9101
LAGOPR	-0.16927	0.87296	-0.19390	-0.0164	-0.15103E-01	-0.84588E-01
D	0.14440	0.16556	0.87222	0.0738	0.12370	0.36929E-01
TIMEDUM	0.14700	0.31103E-01	4.7263	0.3721	0.77963	0.18797
CONSTANT	11.305	1.9267	5.8673	0.4455	0.00000	5.7820

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\oprzd.doc
sample 1 95
read(11) airline year d totocc y n u hours opratio


* generate controlable rate
genr  crate     =  ((1000000*y))/hours

*generate time since deregulation dummy
genr  timedum   =  d*(year - 79)

* generate zero dummy for crate = 0
genr  zerodum   =  dum (.001 - crate)

* generate modified rate with ones where there were zeroes
genr  modcrate  =  crate + zerodum

* generate log of the modified rate
genr  lnmodrat  =  log(modcrate)


print year  crate zerodum modcrate lnmodrat d timedum
opratio


pool lnmodrat year zerodum opratio              /ncross=5
pool lnmodrat year zerodum opratio  d           /ncross=5
pool lnmodrat year zerodum opratio    timedum /ncross=5
pool lnmodrat year zerodum opratio  d  timedum /ncross=5

delete  / all
```

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

```
FILE 11  d:\shazam\d\f1\loprzd.doc
sample 1 90
read(11) airline year d totocc y n u hours lagopr


* generate controlable rate
genr  crate      =  ((1000000*y))/hours

*generate time since deregulation dummy
genr  timedum    =  d*(year - 79)

* generate zero dummy for crate = 0
genr  zerodum    =  dum (.001 - crate)

* generate modified rate with ones where there were zeroes
genr  modcrate   =  crate + zerodum

* generate log of the modified rate
genr  lnmodrat   =  log(modcrate)


print year  crate zerodum modcrate lnmodrat d timedum lagopr


pool lnmodrat year zerodum lagopr              /ncross=5
pool lnmodrat year zerodum lagopr  d           /ncross=5
pool lnmodrat year zerodum lagopr    timedum /ncross=5
pool lnmodrat year zerodum lagopr  d  timedum /ncross=5

delete  / all
```

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\oprzd.doc

9 VARIABLES AND 95 OBSERVATIONS STARTING AT OBS 1

YR	CRATE	ZERODUM	MODCRATE	LNMODRAT	D	TIMEDUM	OPRATIO
70	8.928877	0.00	8.928877	2.189291	0.00	0.00	1.013336
71	15.18077	0.00	15.18077	2.720030	0.00	0.00	0.9769582
72	6.225574	0.00	6.225574	1.828666	0.00	0.00	0.9695126
73	10.58809	0.00	10.58809	2.359730	0.00	0.00	1.024519
74	9.770125	0.00	9.770125	2.279329	0.00	0.00	0.9761608
75	9.524959	0.00	9.524959	2.253916	0.00	0.00	1.015878
76	4.572404	0.00	4.572404	1.520039	0.00	0.00	0.9661233
77	5.956458	0.00	5.956458	1.784476	0.00	0.00	0.9729827
78	5.811799	0.00	5.811799	1.759890	0.00	0.00	0.9644798
79	5.349396	0.00	5.349396	1.676984	0.00	0.00	0.9984729
80	0.0000000	1.0	1.000000	0.0000000	1.0	1.0	1.030660
81	4.914263	0.00	4.914263	1.592142	1.0	2.0	0.9889147
82	4.844727	0.00	4.844727	1.577891	1.0	3.0	1.004587
83	9.104842	0.00	9.104842	2.208806	1.0	4.0	0.9449481
84	6.667938	0.00	6.667938	1.897311	1.0	5.0	0.9333518
85	10.47889	0.00	10.47889	2.349362	1.0	6.0	0.9135595
86	4.228071	0.00	4.228071	1.441746	1.0	7.0	0.9330558
87	5.134278	0.00	5.134278	1.635939	1.0	8.0	0.9335834
88	6.731413	0.00	6.731413	1.906785	1.0	9.0	0.9063228
70	7.091193	0.00	7.091193	1.958854	0.00	0.00	0.8780282
71	9.285590	0.00	9.285590	2.228464	0.00	0.00	0.9103325
72	16.50185	0.00	16.50185	2.803473	0.00	0.00	0.8855433
73	12.49603	0.00	12.49603	2.525411	0.00	0.00	0.8898662
74	13.74549	0.00	13.74549	2.620711	0.00	0.00	0.8797147
75	11.70889	0.00	11.70889	2.460349	0.00	0.00	0.9504106
76	7.463090	0.00	7.463090	2.009970	0.00	0.00	0.9215828
77	5.369416	0.00	5.369416	1.680719	0.00	0.00	0.9069057
78	6.651026	0.00	6.651026	1.894771	0.00	0.00	0.9035657
79	1.557533	0.00	1.557533	0.4431031	0.00	0.00	0.9537052
80	3.023125	0.00	3.023125	1.106291	1.0	1.0	0.9502776
81	4.508349	0.00	4.508349	1.505931	1.0	2.0	0.9762623
82	0.0000000	1.0	1.000000	0.0000000	1.0	3.0	1.023665
83	0.0000000	1.0	1.000000	0.0000000	1.0	4.0	1.014649
84	2.831169	0.00	2.831169	1.040690	1.0	5.0	0.9360994
85	9.454515	0.00	9.454515	2.246492	1.0	6.0	0.9512033
86	1.346910	0.00	1.346910	0.2978132	1.0	7.0	0.9499553
87	5.637069	0.00	5.637069	1.729364	1.0	8.0	0.9287347
88	5.007695	0.00	5.007695	1.610976	1.0	9.0	0.9290386

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY (continued)

70	8.001984	0.00	8.001984	2.079690	0.00	0.00	0.9548052
71	7.852388	0.00	7.852388	2.060818	0.00	0.00	0.9659982
72	13.77653	0.00	13.77653	2.622966	0.00	0.00	0.9542277
73	10.22931	0.00	10.22931	2.325257	0.00	0.00	1.015489
74	8.323636	0.00	8.323636	2.119099	0.00	0.00	0.9537769
75	10.91913	0.00	10.91913	2.390516	0.00	0.00	0.9960571
76	4.512445	0.00	4.512445	1.506839	0.00	0.00	0.9565586
77	5.874190	0.00	5.874190	1.770568	0.00	0.00	0.9830934
78	4.334496	0.00	4.334496	1.466605	0.00	0.00	0.9593276
79	2.754855	0.00	2.754855	1.013365	0.00	0.00	0.9614558
80	2.711273	0.00	2.711273	0.9974181	1.0	1.0	0.9994623
81	9.831668	0.00	9.831668	2.285609	1.0	2.0	1.013401
82	4.402235	0.00	4.402235	1.482112	1.0	3.0	1.004983
83	5.618025	0.00	5.618025	1.725980	1.0	4.0	1.025394
84	5.193153	0.00	5.193153	1.647341	1.0	5.0	0.9565456
85	5.076651	0.00	5.076651	1.624652	1.0	6.0	0.9539746
86	9.830788	0.00	9.830788	2.285519	1.0	7.0	0.9856234
87	8.897170	0.00	8.897170	2.185733	1.0	8.0	0.9869959
88	4.504444	0.00	4.504444	1.505064	1.0	9.0	1.053866
70	11.36593	0.00	11.36593	2.430620	0.00	0.00	1.073206
71	7.411470	0.00	7.411470	2.003029	0.00	0.00	0.9880938
72	11.86926	0.00	11.86926	2.473952	0.00	0.00	0.9470673
73	3.266063	0.00	3.266063	1.183585	0.00	0.00	0.9522793
74	11.38284	0.00	11.38284	2.432107	0.00	0.00	1.010386
75	11.71223	0.00	11.71223	2.460633	0.00	0.00	1.045252
76	0.0000000	1.0	1.000000	0.0000000	0.00	0.00	0.9738675
77	3.240000	0.00	3.240000	1.175573	0.00	0.00	0.9816897
78	1.666647	0.00	1.666647	0.5108140	0.00	0.00	0.9801738
79	3.337789	0.00	3.337789	1.205309	0.00	0.00	1.015234
80	1.952096	0.00	1.952096	0.6689034	1.0	1.0	1.010865
81	2.314531	0.00	2.314531	0.8392070	1.0	2.0	0.9988842
82	7.561989	0.00	7.561989	2.023134	1.0	3.0	1.032190
83	12.13843	0.00	12.13843	2.496376	1.0	4.0	1.019582
84	2.266885	0.00	2.266885	0.8184066	1.0	5.0	0.9793932
85	2.144266	0.00	2.144266	0.7627974	1.0	6.0	1.016468
86	6.270326	0.00	6.270326	1.835828	1.0	7.0	1.023801
87	3.506422	0.00	3.506422	1.254596	1.0	8.0	0.9407275
88	1.645606	0.00	1.645606	0.4981085	1.0	9.0	0.9405159

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

70	11.15222	0.00	11.15222	2.411638	0.00	0.00	1.013977
71	10.91646	0.00	10.91646	2.390272	0.00	0.00	0.9772700
72	4.393113	0.00	4.393113	1.480038	0.00	0.00	0.9560165
73	3.302761	0.00	3.302761	1.194759	0.00	0.00	0.9226813
74	4.887436	0.00	4.887436	1.586668	0.00	0.00	0.9204581
75	6.506147	0.00	6.506147	1.872747	0.00	0.00	1.002413
76	1.231834	0.00	1.231834	0.2085037	0.00	0.00	0.9870916
77	4.708248	0.00	4.708248	1.549316	0.00	0.00	0.9728370
78	6.476209	0.00	6.476209	1.868135	0.00	0.00	0.9178491
79	1.227556	0.00	1.227556	0.2050249	0.00	0.00	1.073398
80	3.257690	0.00	3.257690	1.181018	1.0	1.0	1.015533
81	3.955837	0.00	3.955837	1.375192	1.0	2.0	1.032823
82	2.630862	0.00	2.630862	0.9673117	1.0	3.0	1.014857
83	9.602769	0.00	9.602769	2.262052	1.0	4.0	0.9711791
84	7.402707	0.00	7.402707	2.001846	1.0	5.0	0.9097885
85	2.419743	0.00	2.419743	0.8836614	1.0	6.0	1.066666
86	4.457436	0.00	4.457436	1.494574	1.0	7.0	1.001496
87	4.088518	0.00	4.088518	1.408183	1.0	8.0	0.9807680
88	2.496083	0.00	2.496083	0.9147228	1.0	9.0	0.9239948

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY (continued)

POOLED CROSS-SECTION TIME-SERIES ESTIMATION
5 CROSS-SECTIONS AND 19 TIME-PERIODS
95 TOTAL OBSERVATIONS
DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.4108 BUSE RAW-MOMENT R-SQUARE = 0.8835
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.81432
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.90240
SUM OF SQUARED ERRORS-SSE= 74.103
MEAN OF DEPENDENT VARIABLE = 1.6270
LOG OF THE LIKELIHOOD FUNCTION = -71.2998

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 91 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.44851E-01	0.11764E-01	-3.8127	-0.3711	-0.35292	-2.1777
ZERODUM	-1.5886	0.25687	-6.1846	-0.5440	-0.45834	-0.41111E-01
OPRATIO	-1.6587	1.3227	-1.2540	-0.1303	-0.10421	-0.99242
CONSTANT	6.8885	1.5833	4.3507	0.4150	0.00000	4.2338

DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.4191 BUSE RAW-MOMENT R-SQUARE = 0.8932
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.76733
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.87598
SUM OF SQUARED ERRORS-SSE= 69.060
MEAN OF DEPENDENT VARIABLE = 1.6270
LOG OF THE LIKELIHOOD FUNCTION = -70.3050

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 90 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.71026E-01	0.21492E-01	-3.3048	-0.3290	-0.55887	-3.4486
ZERODUM	-1.6732	0.26870	-6.2268	-0.5487	-0.48273	-0.43299E-01
OPRATIO	-2.1365	1.3245	-1.6130	-0.1676	-0.13422	-1.2783
D	0.35088	0.23857	1.4707	0.1532	0.25168	0.10215
CONSTANT	9.2570	2.1876	4.2315	0.4074	0.00000	5.6895

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.4915 BUSE RAW-MOMENT R-SQUARE = 0.9149
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.76529
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.87481
SUM OF SQUARED ERRORS-SSE= 68.876
MEAN OF DEPENDENT VARIABLE = 1.6270
LOG OF THE LIKELIHOOD FUNCTION = -66.1001

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 90 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11470	0.22970E-01	-4.9934	-0.4658	-0.90249	-5.5690
ZERODUM	-1.5104	0.24443	-6.1793	-0.5458	-0.43576	-0.39086E-01
OPRATIO	-0.96362	1.2433	-0.77507	-0.0814	-0.60538E-01	-0.57653
TIMEDUM	0.14113	0.40888E-01	3.4517	0.3419	0.62132	0.20544
CONSTANT	11.392	1.9353	5.8864	0.5272	0.00000	7.0016

DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.4870 BUSE RAW-MOMENT R-SQUARE = 0.9163
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.71809
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.84740
SUM OF SQUARED ERRORS-SSE= 63.910
MEAN OF DEPENDENT VARIABLE = 1.6270
LOG OF THE LIKELIHOOD FUNCTION = -65.8931

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 89 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.12342	0.25859E-01	-4.7729	-0.4514	-0.97115	-5.9926
ZERODUM	-1.5513	0.25858	-5.9992	-0.5366	-0.44755	-0.40144E-01
OPRATIO	-1.2307	1.2821	-0.95991	-0.1012	-0.77315E-01	-0.73631
D	0.17760	0.22902	0.77546	0.0819	0.12739	0.51704E-01
TIMEDUM	0.13255	0.42281E-01	3.1349	0.3153	0.58351	0.19294
CONSTANT	12.276	2.2478	5.4613	0.5010	0.00000	7.5450

ALL VARIABLES HAVE BEEN DELETED

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\loprzd.doc

9 VARIABLES AND 90 OBSERVATIONS STARTING AT OBS 1

YR	CRATE	ZERODUM	MODCRATE	LNMODRAT	D	TIMEDUM	LAGOPR
71	15.18077	0.00	15.18077	2.720030	0.00	0.00	1.013336
72	6.225574	0.00	6.225574	1.828666	0.00	0.00	0.9769582
73	10.58809	0.00	10.58809	2.359730	0.00	0.00	0.9695126
74	9.770125	0.00	9.770125	2.279329	0.00	0.00	1.024519
75	9.524959	0.00	9.524959	2.253916	0.00	0.00	0.9761608
76	4.572404	0.00	4.572404	1.520039	0.00	0.00	1.015878
77	5.956458	0.00	5.956458	1.784476	0.00	0.00	0.9661233
78	5.811799	0.00	5.811799	1.759890	0.00	0.00	0.9729827
79	5.349396	0.00	5.349396	1.676984	0.00	0.00	0.9644798
80	0.0000000	1.0	1.000000	0.0000000	1.0	1.0	0.9984729
81	4.914263	0.00	4.914263	1.592142	1.0	2.0	1.030660
82	4.844727	0.00	4.844727	1.577891	1.0	3.0	0.9889147
83	9.104842	0.00	9.104842	2.208806	1.0	4.0	1.004587
84	6.667938	0.00	6.667938	1.897311	1.0	5.0	0.9449481
85	10.47889	0.00	10.47889	2.349362	1.0	6.0	0.9333518
86	4.228071	0.00	4.228071	1.441746	1.0	7.0	0.9135595
87	5.134278	0.00	5.134278	1.635939	1.0	8.0	0.9330558
88	6.731413	0.00	6.731413	1.906785	1.0	9.0	0.9335834
71	9.285590	0.00	9.285590	2.228464	0.00	0.00	0.8780282
72	16.50185	0.00	16.50185	2.803473	0.00	0.00	0.9103325
73	12.49603	0.00	12.49603	2.525411	0.00	0.00	0.8855433
74	13.74549	0.00	13.74549	2.620711	0.00	0.00	0.8898662
75	11.70889	0.00	11.70889	2.460349	0.00	0.00	0.8797147
76	7.463090	0.00	7.463090	2.009970	0.00	0.00	0.9504106
77	5.369416	0.00	5.369416	1.680719	0.00	0.00	0.9215828
78	6.651026	0.00	6.651026	1.894771	0.00	0.00	0.9069057
79	1.557533	0.00	1.557533	0.4431031	0.00	0.00	0.9035657
80	3.023125	0.00	3.023125	1.106291	1.0	1.0	0.9537052
81	4.508349	0.00	4.508349	1.505931	1.0	2.0	0.9502776
82	0.0000000	1.0	1.000000	0.0000000	1.0	3.0	0.9762623
83	0.0000000	1.0	1.000000	0.0000000	1.0	4.0	1.023665
84	2.831169	0.00	2.831169	1.040690	1.0	5.0	1.014649
85	9.454515	0.00	9.454515	2.246492	1.0	6.0	0.9360994
86	1.346910	0.00	1.346910	0.2978132	1.0	7.0	0.9512033
87	5.637069	0.00	5.637069	1.729364	1.0	8.0	0.9499553
88	5.007695	0.00	5.007695	1.610976	1.0	9.0	0.9287347

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

71	7.852388	0.00	7.852388	2.060818	0.00	0.00	0.9548052
72	13.77653	0.00	13.77653	2.622966	0.00	0.00	0.9659982
73	10.22931	0.00	10.22931	2.325257	0.00	0.00	0.9542277
74	8.323636	0.00	8.323636	2.119099	0.00	0.00	1.015489
75	10.91913	0.00	10.91913	2.390516	0.00	0.00	0.9537769
76	4.512445	0.00	4.512445	1.506839	0.00	0.00	0.9960571
77	5.874190	0.00	5.874190	1.770568	0.00	0.00	0.9565586
78	4.334496	0.00	4.334496	1.466605	0.00	0.00	0.9830934
79	2.754855	0.00	2.754855	1.013365	0.00	0.00	0.9593276
80	2.711273	0.00	2.711273	0.9974181	1.0	1.0	0.9614558
81	9.831668	0.00	9.831668	2.285609	1.0	2.0	0.9994623
82	4.402235	0.00	4.402235	1.482112	1.0	3.0	1.013401
83	5.618025	0.00	5.618025	1.725980	1.0	4.0	1.004983
84	5.193153	0.00	5.193153	1.647341	1.0	5.0	1.025394
85	5.076651	0.00	5.076651	1.624652	1.0	6.0	0.9565456
86	9.830788	0.00	9.830788	2.285519	1.0	7.0	0.9539746
87	8.897170	0.00	8.897170	2.185733	1.0	8.0	0.9856234
88	4.504444	0.00	4.504444	1.505064	1.0	9.0	0.9869959
71	7.411470	0.00	7.411470	2.003029	0.00	0.00	1.073206
72	11.86926	0.00	11.86926	2.473952	0.00	0.00	0.9880938
73	3.266063	0.00	3.266063	1.183585	0.00	0.00	0.9470673
74	11.38284	0.00	11.38284	2.432107	0.00	0.00	0.9522793
75	11.71223	0.00	11.71223	2.460633	0.00	0.00	1.010386
76	0.0000000	1.0	1.000000	0.0000000	0.00	0.00	1.045252
77	3.240000	0.00	3.240000	1.175573	0.00	0.00	0.9738675
78	1.666647	0.00	1.666647	0.5108140	0.00	0.00	0.9816897
79	3.337789	0.00	3.337789	1.205309	0.00	0.00	0.9801738
80	1.952096	0.00	1.952096	0.6689034	1.0	1.0	1.015234
81	2.314531	0.00	2.314531	0.8392070	1.0	2.0	1.010865
82	7.561989	0.00	7.561989	2.023134	1.0	3.0	0.9988842
83	12.13843	0.00	12.13843	2.496376	1.0	4.0	1.032190
84	2.266885	0.00	2.266885	0.8184066	1.0	5.0	1.019582
85	2.144266	0.00	2.144266	0.7627974	1.0	6.0	0.9793932
86	6.270326	0.00	6.270326	1.835828	1.0	7.0	1.016468
87	3.506422	0.00	3.506422	1.254596	1.0	8.0	1.023801
88	1.645606	0.00	1.645606	0.4981085	1.0	9.0	0.9407275

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY
(continued)

71	10.91646	0.00	10.91646	2.390272	0.00	0.00	1.013977
72	4.393113	0.00	4.393113	1.480038	0.00	0.00	0.9772700
73	3.302761	0.00	3.302761	1.194759	0.00	0.00	0.9560165
74	4.887436	0.00	4.887436	1.586668	0.00	0.00	0.9226813
75	6.506147	0.00	6.506147	1.872747	0.00	0.00	0.9204581
76	1.231834	0.00	1.231834	0.2085037	0.00	0.00	1.002413
77	4.708248	0.00	4.708248	1.549316	0.00	0.00	0.9870916
78	6.476209	0.00	6.476209	1.868135	0.00	0.00	0.9728370
79	1.227556	0.00	1.227556	0.2050249	0.00	0.00	0.9178491
80	3.257690	0.00	3.257690	1.181018	1.0	1.0	1.073398
81	3.955837	0.00	3.955837	1.375192	1.0	2.0	1.015533
82	2.630862	0.00	2.630862	0.9673117	1.0	3.0	1.032823
83	9.602769	0.00	9.602769	2.262052	1.0	4.0	1.014857
84	7.402707	0.00	7.402707	2.001846	1.0	5.0	0.9711791
85	2.419743	0.00	2.419743	0.8836614	1.0	6.0	0.9097885
86	4.457436	0.00	4.457436	1.494574	1.0	7.0	1.066666
87	4.088518	0.00	4.088518	1.408183	1.0	8.0	1.001496
88	2.496083	0.00	2.496083	0.9147228	1.0	9.0	0.9807680

APPENDIX J

OPERATING RATIO WITH ZERO DUMMY (continued)

DEPENDENT VARIABLE = LNMODRAT
BUSE R-SQUARE = 0.3775   BUSE RAW-MOMENT R-SQUARE = 0.8693
SUM OF SQUARED ERRORS-SSE= 69.047
LOG OF THE LIKELIHOOD FUNCTION = -70.2680

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 86 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.43520E-01	0.13353E-01	-3.2593	-0.3316	-0.32276	-2.1700
ZERODUM	-1.6363	0.26669	-6.1356	-0.5518	-0.48203	-0.45611E-01
LAGOPR	-0.63141	1.4579	-0.43309	-0.0466	-0.38653E-01	-0.38600
CONSTANT	5.7859	1.7279	3.3486	0.3396	0.00000	3.6288

BUSE R-SQUARE = 0.3874   BUSE RAW-MOMENT R-SQUARE = 0.8798
SUM OF SQUARED ERRORS-SSE= 64.017
LOG OF THE LIKELIHOOD FUNCTION = -69.4198

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 85 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.71581E-01	0.24639E-01	-2.9052	-0.3005	-0.53087	-3.5691
ZERODUM	-1.7224	0.27709	-6.2159	-0.5590	-0.50739	-0.48010E-01
LAGOPR	-1.2950	1.5030	-0.86163	-0.0931	-0.79277E-01	-0.79167
D	0.35907	0.26177	1.3717	0.1472	0.25665	0.11260
CONSTANT	8.4846	2.5834	3.2843	0.3356	0.00000	5.3214

BUSE R-SQUARE = 0.5224   BUSE RAW-MOMENT R-SQUARE = 0.9163
SUM OF SQUARED ERRORS-SSE= 63.643
LOG OF THE LIKELIHOOD FUNCTION = -63.1460

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 85 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.14325	0.26149E-01	-5.4782	-0.5108	-1.0624	-7.1426
ZERODUM	-1.5307	0.23492	-6.5156	-0.5771	-0.45092	-0.42667E-01
LAGOPR	-0.45915	1.2855	-0.35718	-0.0387	-0.28108E-01	-0.28069
TIMEDUM	0.17957	0.43507E-01	4.1273	0.4086	0.79464	0.28156
CONSTANT	13.103	2.1986	5.9599	0.5429	0.00000	8.2181

BUSE R-SQUARE = 0.5226   BUSE RAW-MOMENT R-SQUARE = 0.9195
SUM OF SQUARED ERRORS-SSE= 58.672
LOG OF THE LIKELIHOOD FUNCTION = -62.7964

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 84 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.15612	0.29669E-01	-5.2621	-0.4979	-1.1579	-7.7844
ZERODUM	-1.5868	0.24851	-6.3851	-0.5716	-0.46745	-0.44231E-01
LAGOPR	-0.85039	1.3469	-0.63135	-0.0687	-0.52058E-01	-0.51986
D	0.22136	0.23487	0.94248	0.1023	0.15822	0.69418E-01
TIMEDUM	0.17213	0.43644E-01	3.9440	0.3953	0.76172	0.26989
CONSTANT	14.415	2.6170	5.5081	0.5151	0.00000	9.0405

APPENDIX K

CUSUM TEST

APPENDIX K

CUSUM TEST

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controlable rate
genr  crate     =  ((1000000*y))/hours

* generate log of the controlable rate
genr  lncrate  =  log(crate)

* generate time since deregulation dummy
genr timedum   = d*(year - 79)
print y hours crate lncrate year

ols   lncrate   year                  /exactdw
diagnos /recur siglevel=1
ols   lncrate   year                  /exactdw
diagnos /recur siglevel=5
ols   lncrate   year                  /exactdw
diagnos /recur siglevel=10
delete  / all
```

APPENDIX K

CUSUM TEST
(continued)

```
FILE 11  d:\shazam\d\f1\fatacc.doc
sample 1 27
read(11) year fatal acc hours
* generate accident rate
genr  accrate    =  (1000000*acc)/hours

* generate log of the accident rate
genr  lnaccrat  =  log(accrate)

* generate deregulation dummy
genr d    = dum(year - 79.9)

genr timedum   = d*(year - 79)

print year  acc accrate   lnaccrat hours

ols   lnaccrat   year                        /exactdw
diagnos /recur siglevel=1

ols   lnaccrat   year                        /exactdw
diagnos /recur siglevel=5

ols   lnaccrat   year                        /exactdw
diagnos /recur siglevel=10
delete  / all
```

APPENDIX K

CUSUM TEST
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

Y	HOURS	CRATE	LNCRATE	YEAR
64.00000	2441185.	26.21678	3.266400	64.00000
45.00000	2691129.	16.72161	2.816702	65.00000
45.00000	2819170.	15.96214	2.770220	66.00000
48.00000	3507054.	13.68670	2.616425	67.00000
43.00000	4015838.	10.70760	2.370954	68.00000
44.00000	4336713.	10.14593	2.317073	69.00000
44.00000	4294706.	10.24517	2.326807	70.00000
48.00000	4224634.	11.36193	2.430268	71.00000
40.00000	4204233.	9.514221	2.252788	72.00000
30.00000	4346571.	6.901992	1.931810	73.00000
34.00000	3997587.	8.505131	2.140670	74.00000
36.00000	3936489.	9.145205	2.213230	75.00000
14.00000	4024069.	3.479066	1.246764	76.00000
20.00000	4135728.	4.835908	1.576069	77.00000
20.00000	4166439.	4.800262	1.568671	78.00000
14.00000	4329449.	3.233668	1.173617	79.00000
9.000000	4439343.	2.027327	0.7067182	80.00000
27.00000	4049954.	6.666742	1.897131	81.00000
15.00000	4016962.	3.734165	1.317524	82.00000
32.00000	4197657.	7.623300	2.031209	83.00000
24.00000	4547810.	5.277265	1.663408	84.00000
25.00000	4744502.	5.269257	1.661889	85.00000
26.00000	5389885.	4.823851	1.573572	86.00000
36.00000	6921046.	5.201526	1.648952	87.00000
33.00000	7166746.	4.604600	1.527056	88.00000

APPENDIX K

CUSUM TEST
(continued)

```
 OLS ESTIMATION
       25 OBSERVATIONS      DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC  =   1.25148
DURBIN-WATSON PROBABILITY =    0.013625
 R-SQUARE =    0.5997      R-SQUARE ADJUSTED =    0.5823
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14607
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.38219
 SUM OF SQUARED ERRORS-SSE=   3.3596
 MEAN OF DEPENDENT VARIABLE =   1.9618
 LOG OF THE LIKELIHOOD FUNCTION = -10.3853
 VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR      23 DF      CORR.  COEFFICIENT  AT MEANS
 YEAR     -0.62229E-01 0.10600E-01  -5.8706    -0.7744 -0.77443      -2.4107
 CONSTANT   6.6912     0.80922       8.2687     0.8650  0.00000       3.4107

DEPENDENT VARIABLE = LNCRATE          25 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.622288231606E-01   6.69122759973
 RECURSIVE COEFFICIENT ESTIMATES
    2 -0.44970        32.047
    3 -0.24809        19.077
    4 -0.19964        15.944
    5 -0.19912        15.910
    6 -0.17822        14.545
    7 -0.15062        12.732
    8 -0.11794        10.576
    9 -0.10667        9.8274
   10 -0.11261        10.224
   11 -0.10125        9.4623
   12 -0.88002E-01    8.5706
   13 -0.10896        9.9886
   14 -0.10961        10.033
   15 -0.10748        9.8871
   16 -0.11239        10.225
   17 -0.12272        10.937
   18 -0.10693        9.8423
   19 -0.10309        9.5748
   20 -0.88621E-01    8.5622
   21 -0.81538E-01    8.0640
   22 -0.75270E-01    7.6211
   23 -0.70643E-01    7.2926
   24 -0.65620E-01    6.9342
   25 -0.62229E-01    6.6912
```

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 1%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16461	0.48425	5.9583	-0.36464	0.00807	0.45160
4	0.88456E-01	0.74446	6.4350	-0.32116	0.01039	0.49508
5	0.16565E-02	0.74933	6.9116	-0.27768	0.01040	0.53855
6	0.10095	1.04629	7.3883	-0.23421	0.01343	0.58203
7	0.18855	1.60096	7.8650	-0.19073	0.02401	0.62551
8	0.29946	2.48189	8.3416	-0.14725	0.05070	0.66899
9	0.13345	2.87447	8.8183	-0.10377	0.05600	0.71247
10	-0.88221E-01	2.61495	9.2949	-0.06029	0.05832	0.75595
11	0.20651	3.22245	9.7716	-0.01681	0.07101	0.79942
12	0.28914	4.07302	10.2483	0.02666	0.09590	0.84290
13	-0.54136	2.48049	10.7249	0.07014	0.18313	0.88638
14	-0.19627E-01	2.42275	11.2016	0.11362	0.18325	0.92986
15	0.74276E-01	2.64125	11.6783	0.15710	0.18489	0.97334
16	-0.19585	2.06511	12.1549	0.20058	0.19631	1.01681
17	-0.46636	0.69320	12.6316	0.24405	0.26104	1.06029
18	0.80273	3.05462	13.1083	0.28753	0.45284	1.10377
19	0.21824	3.69663	13.5849	0.33101	0.46702	1.14725
20	0.91376	6.38467	14.0616	0.37449	0.71555	1.19073
21	0.49461	7.83970	14.5383	0.41797	0.78837	1.23421
22	0.48159	9.25640	15.0149	0.46145	0.85740	1.27768
23	0.38946	10.40210	15.4916	0.50492	0.90255	1.32116
24	0.46130	11.75912	15.9682	0.54840	0.96589	1.36464
25	0.33853	12.75497	16.4449	0.59188	1.00000	1.40812

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = 2.6596 WITH 22 D.F.

HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 9.7699 WITH M = 7

APPENDIX K

CUSUM TEST
(continued)

```
 OLS ESTIMATION
       25 OBSERVATIONS     DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC  =   1.25148
DURBIN-WATSON PROBABILITY =    0.013625
 R-SQUARE =    0.5997     R-SQUARE ADJUSTED =    0.5823
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14607
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.38219
 SUM OF SQUARED ERRORS-SSE=   3.3596
 MEAN OF DEPENDENT VARIABLE =   1.9618
 LOG OF THE LIKELIHOOD FUNCTION = -10.3853
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.62229E-01	0.10600E-01	-5.8706	-0.7744	-0.77443	-2.4107
CONSTANT	6.6912	0.80922	8.2687	0.8650	0.00000	3.4107

```
 REQUIRED MEMORY IS PAR=    5 CURRENT PAR=  500
 DEPENDENT VARIABLE = LNCRATE          25 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.622288231606E-01    6.69122759973
 RECURSIVE COEFFICIENT ESTIMATES
```

2	-0.44970	32.047
3	-0.24809	19.077
4	-0.19964	15.944
5	-0.19912	15.910
6	-0.17822	14.545
7	-0.15062	12.732
8	-0.11794	10.576
9	-0.10667	9.8274
10	-0.11261	10.224
11	-0.10125	9.4623
12	-0.88002E-01	8.5706
13	-0.10896	9.9886
14	-0.10961	10.033
15	-0.10748	9.8871
16	-0.11239	10.225
17	-0.12272	10.937
18	-0.10693	9.8423
19	-0.10309	9.5748
20	-0.88621E-01	8.5622
21	-0.81538E-01	8.0640
22	-0.75270E-01	7.6211
23	-0.70643E-01	7.2926
24	-0.65620E-01	6.9342
25	-0.62229E-01	6.6912

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 5%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16461	0.48425	4.9418	-0.29105	0.00807	0.37801
4	0.88456E-01	0.74446	5.3371	-0.24757	0.01039	0.42149
5	0.16565E-02	0.74933	5.7325	-0.20410	0.01040	0.46497
6	0.10095	1.04629	6.1278	-0.16062	0.01343	0.50844
7	0.18855	1.60096	6.5232	-0.11714	0.02401	0.55192
8	0.29946	2.48189	6.9185	-0.07366	0.05070	0.59540
9	0.13345	2.87447	7.3139	-0.03018	0.05600	0.63888
10	-0.88221E-01	2.61495	7.7092	0.01329	0.05832	0.68236
11	0.20651	3.22245	8.1045	0.05677	0.07101	0.72584
12	0.28914	4.07302	8.4999	0.10025	0.09590	0.76931
13	-0.54136	2.48049	8.8952	0.14373	0.18313	0.81279
14	-0.19627E-01	2.42275	9.2906	0.18721	0.18325	0.85627
15	0.74276E-01	2.64125	9.6859	0.23069	0.18489	0.89975
16	-0.19585	2.06511	10.0813	0.27416	0.19631	0.94323
17	-0.46636	0.69320	10.4766	0.31764	0.26104	0.98671
18	0.80273	3.05462	10.8719	0.36112	0.45284	1.03018
19	0.21824	3.69663	11.2673	0.40460	0.46702	1.07366
20	0.91376	6.38467	11.6626	0.44808	0.71555	1.11714
21	0.49461	7.83970	12.0580	0.49156	0.78837	1.16062
22	0.48159	9.25640	12.4533	0.53503	0.85740	1.20410
23	0.38946	10.40210	12.8487	0.57851	0.90255	1.24757
24	0.46130	11.75912	13.2440	0.62199	0.96589	1.29105
25	0.33853	12.75497	13.6393	0.66547	1.00000	1.33453

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = 2.6596 WITH 22 D.F.

HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 9.7699 WITH M = 7

APPENDIX K

CUSUM TEST (continued)

```
 OLS ESTIMATION
       25 OBSERVATIONS     DEPENDENT VARIABLE = LNCRATE
DURBIN-WATSON STATISTIC  =   1.25148
DURBIN-WATSON PROBABILITY =    0.013625
 R-SQUARE =   0.5997     R-SQUARE ADJUSTED =   0.5823
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.14607
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.38219
 SUM OF SQUARED ERRORS-SSE=  3.3596
 MEAN OF DEPENDENT VARIABLE =   1.9618
 LOG OF THE LIKELIHOOD FUNCTION = -10.3853
```

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.62229E-01	0.10600E-01	-5.8706	-0.7744	-0.77443	-2.4107
CONSTANT	6.6912	0.80922	8.2687	0.8650	0.00000	3.4107

```
DEPENDENT VARIABLE = LNCRATE         25 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.622288231606E-01   6.69122759973
 RECURSIVE COEFFICIENT ESTIMATES
```

2	-0.44970	32.047
3	-0.24809	19.077
4	-0.19964	15.944
5	-0.19912	15.910
6	-0.17822	14.545
7	-0.15062	12.732
8	-0.11794	10.576
9	-0.10667	9.8274
10	-0.11261	10.224
11	-0.10125	9.4623
12	-0.88002E-01	8.5706
13	-0.10896	9.9886
14	-0.10961	10.033
15	-0.10748	9.8871
16	-0.11239	10.225
17	-0.12272	10.937
18	-0.10693	9.8423
19	-0.10309	9.5748
20	-0.88621E-01	8.5622
21	-0.81538E-01	8.0640
22	-0.75270E-01	7.6211
23	-0.70643E-01	7.2926
24	-0.65620E-01	6.9342
25	-0.62229E-01	6.6912

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL =10%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16461	0.48425	4.4309	-0.25375	0.00807	0.34071
4	0.88456E-01	0.74446	4.7854	-0.21027	0.01039	0.38419
5	0.16565E-02	0.74933	5.1399	-0.16680	0.01040	0.42767
6	0.10095	1.04629	5.4944	-0.12332	0.01343	0.47114
7	0.18855	1.60096	5.8488	-0.07984	0.02401	0.51462
8	0.29946	2.48189	6.2033	-0.03636	0.05070	0.55810
9	0.13345	2.87447	6.5578	0.00712	0.05600	0.60158
10	-0.88221E-01	2.61495	6.9123	0.05060	0.05832	0.64506
11	0.20651	3.22245	7.2667	0.09407	0.07101	0.68853
12	0.28914	4.07302	7.6212	0.13755	0.09590	0.73201
13	-0.54136	2.48049	7.9757	0.18103	0.18313	0.77549
14	-0.19627E-01	2.42275	8.3302	0.22451	0.18325	0.81897
15	0.74276E-01	2.64125	8.6846	0.26799	0.18489	0.86245
16	-0.19585	2.06511	9.0391	0.31147	0.19631	0.90593
17	-0.46636	0.69320	9.3936	0.35494	0.26104	0.94940
18	0.80273	3.05462	9.7480	0.39842	0.45284	0.99288
19	0.21824	3.69663	10.1025	0.44190	0.46702	1.03636
20	0.91376	6.38467	10.4570	0.48538	0.71555	1.07984
21	0.49461	7.83970	10.8115	0.52886	0.78837	1.12332
22	0.48159	9.25640	11.1659	0.57233	0.85740	1.16680
23	0.38946	10.40210	11.5204	0.61581	0.90255	1.21027
24	0.46130	11.75912	11.8749	0.65929	0.96589	1.25375
25	0.33853	12.75497	12.2294	0.70277	1.00000	1.29723

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = 2.6596 WITH 22 D.F.
HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 9.7699 WITH M = 7

ALL VARIABLES HAVE BEEN DELETED

APPENDIX K

CUSUM TEST
(continued)

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\fatacc.doc

4 VARIABLES AND 27 OBSERVATIONS STARTING AT OBS 1

YEAR	ACC	ACCRATE	LNACCRAT	HOURS
61.00000	66.00000	18.05991	2.893695	3654503.
62.00000	47.00000	13.46252	2.599910	3491174.
63.00000	54.00000	14.98240	2.706876	3604228.
64.00000	59.00000	15.63009	2.749198	3774771.
65.00000	65.00000	15.96272	2.770256	4071987.
66.00000	56.00000	13.22944	2.582445	4232982.
67.00000	54.00000	10.96652	2.394847	4924080.
68.00000	56.00000	10.14138	2.316624	5521931.
69.00000	51.00000	8.655431	2.158187	5892254.
70.00000	43.00000	7.438799	2.006709	5780503.
71.00000	43.00000	7.535571	2.019635	5706270.
72.00000	46.00000	8.127948	2.095308	5659485.
73.00000	36.00000	6.103169	1.808808	5898575.
74.00000	43.00000	7.854606	2.061100	5474495.
75.00000	30.00000	5.532335	1.710610	5422665.
76.00000	22.00000	3.937289	1.370492	5587601.
77.00000	20.00000	3.447775	1.237729	5800843.
78.00000	20.00000	3.315791	1.198696	6031743.
79.00000	23.00000	3.432671	1.233339	6700322.
80.00000	15.00000	2.206668	0.7914838	6797578.
81.00000	25.00000	3.804429	1.336166	6571288.
82.00000	15.00000	2.329134	0.8454964	6440163.
83.00000	22.00000	3.308764	1.196575	6649009.
84.00000	12.00000	1.613229	0.4782378	7438497.
85.00000	17.00000	2.139055	0.7603641	7947435.
86.00000	20.00000	2.137459	0.7596176	9356906.
87.00000	30.00000	3.089280	1.127938	9711000.

APPENDIX K

CUSUM TEST
(continued)

```
 OLS ESTIMATION
       27 OBSERVATIONS     DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC  =   1.80983
DURBIN-WATSON PROBABILITY =    0.236618
 R-SQUARE =   0.9172      R-SQUARE ADJUSTED =   0.9138
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.46718E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.21614
 SUM OF SQUARED ERRORS-SSE=   1.1679
 MEAN OF DEPENDENT VARIABLE =    1.7485
 LOG OF THE LIKELIHOOD FUNCTION =  4.08665
VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT   ERROR     25 DF      CORR.  COEFFICIENT  AT MEANS
 YEAR     -0.88846E-01 0.53405E-02 -16.636    -0.9577 -0.95768      -3.7601
 CONSTANT  8.3231      0.39738      20.945     0.9727  0.00000       4.7601

 REQUIRED MEMORY IS PAR=    6 CURRENT PAR=  500
 DEPENDENT VARIABLE = LNACCRAT        27 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.888459968996E-01   8.32313497880
 RECURSIVE COEFFICIENT ESTIMATES
    2 -0.29379        20.815
    3 -0.93409E-01    8.5249
    4 -0.32652E-01    4.7782
    5 -0.97589E-02    3.3588
    6 -0.28654E-01    4.5366
    7 -0.52432E-01    6.0267
    8 -0.64489E-01    6.7862
    9 -0.76378E-01    7.5393
   10 -0.86528E-01    8.1854
   11 -0.87543E-01    8.2504
   12 -0.81851E-01    7.8842
   13 -0.85158E-01    8.0981
   14 -0.77595E-01    7.6065
   15 -0.79501E-01    7.7310
   16 -0.86526E-01    8.1923
   17 -0.92253E-01    8.5703
   18 -0.95339E-01    8.7750
   19 -0.95495E-01    8.7854
   20 -0.10056        9.1245
   21 -0.95924E-01    8.8126
   22 -0.97126E-01    8.8939
   23 -0.93168E-01    8.6248
   24 -0.96373E-01    8.8438
   25 -0.95374E-01    8.7752
   26 -0.93779E-01    8.6652
   27 -0.88846E-01    8.3231
```

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 1%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16361	0.74166	6.1722	-0.35471	0.02292	0.43471
4	0.11093	1.24450	6.6294	-0.31471	0.03345	0.47471
5	0.72396E-01	1.57268	7.0866	-0.27471	0.03794	0.51471
6	-0.91272E-01	1.15893	7.5438	-0.23471	0.04507	0.55471
7	-0.16243	0.42259	8.0010	-0.19471	0.06766	0.59471
8	-0.11050	-0.07833	8.4582	-0.15471	0.07812	0.63471
9	-0.14068	-0.71606	8.9154	-0.11471	0.09506	0.67471
10	-0.15054	-1.39848	9.3726	-0.07471	0.11447	0.71471
11	-0.18445E-01	-1.48209	9.8298	-0.03471	0.11476	0.75471
12	0.12427	-0.91877	10.2870	0.00529	0.12798	0.79471
13	-0.85418E-01	-1.30599	10.7442	0.04529	0.13423	0.83471
14	0.22815	-0.27176	11.2014	0.08529	0.17879	0.87471
15	-0.66407E-01	-0.57279	11.6586	0.12529	0.18257	0.91471
16	-0.27981	-1.84121	12.1158	0.16529	0.24960	0.95471
17	-0.25868	-3.01387	12.5730	0.20529	0.30690	0.99471
18	-0.15685	-3.72488	13.0302	0.24529	0.32796	1.03471
19	-0.88801E-02	-3.76514	13.4874	0.28529	0.32803	1.07471
20	-0.31974	-5.21456	13.9446	0.32529	0.41556	1.11471
21	0.32351	-3.74803	14.4018	0.36529	0.50517	1.15471
22	-0.92331E-01	-4.16658	14.8590	0.40529	0.51247	1.19471
23	0.33308	-2.65665	15.3162	0.44529	0.60746	1.23471
24	-0.29428	-3.99065	15.7734	0.48529	0.68161	1.27471
25	0.99762E-01	-3.53841	16.2306	0.52529	0.69013	1.31471
26	0.17248	-2.75655	16.6878	0.56529	0.71560	1.35471
27	0.57633	-0.14393	17.1450	0.60529	1.00000	1.39471

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = -0.0288 WITH 24 D.F.

HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 5.8704 WITH M = 8

APPENDIX K

CUSUM TEST
(continued)

```
 OLS ESTIMATION
       27 OBSERVATIONS     DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC  =    1.80983
DURBIN-WATSON PROBABILITY =    0.236618
 R-SQUARE =    0.9172      R-SQUARE ADJUSTED =    0.9138
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.46718E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.21614
 SUM OF SQUARED ERRORS-SSE=   1.1679
 MEAN OF DEPENDENT VARIABLE =   1.7485
 LOG OF THE LIKELIHOOD FUNCTION =  4.08665
VARIABLE    ESTIMATED    STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR      25 DF      CORR.  COEFFICIENT  AT MEANS
 YEAR     -0.88846E-01 0.53405E-02  -16.636    -0.9577 -0.95768      -3.7601
 CONSTANT   8.3231     0.39738       20.945     0.9727  0.00000       4.7601

 REQUIRED MEMORY IS PAR=    6 CURRENT PAR=  500
 DEPENDENT VARIABLE = LNACCRAT        27 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.888459968996E-01   8.32313497880
 RECURSIVE COEFFICIENT ESTIMATES
    2 -0.29379       20.815
    3 -0.93409E-01   8.5249
    4 -0.32652E-01   4.7782
    5 -0.97589E-02   3.3588
    6 -0.28654E-01   4.5366
    7 -0.52432E-01   6.0267
    8 -0.64489E-01   6.7862
    9 -0.76378E-01   7.5393
   10 -0.86528E-01   8.1854
   11 -0.87543E-01   8.2504
   12 -0.81851E-01   7.8842
   13 -0.85158E-01   8.0981
   14 -0.77595E-01   7.6065
   15 -0.79501E-01   7.7310
   16 -0.86526E-01   8.1923
   17 -0.92253E-01   8.5703
   18 -0.95339E-01   8.7750
   19 -0.95495E-01   8.7854
   20 -0.10056       9.1245
   21 -0.95924E-01   8.8126
   22 -0.97126E-01   8.8939
   23 -0.93168E-01   8.6248
   24 -0.96373E-01   8.8438
   25 -0.95374E-01   8.7752
   26 -0.93779E-01   8.6652
   27 -0.88846E-01   8.3231
```

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL = 5%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16361	0.74166	5.1192	-0.28368	0.02292	0.36368
4	0.11093	1.24450	5.4984	-0.24368	0.03345	0.40368
5	0.72396E-01	1.57268	5.8776	-0.20368	0.03794	0.44368
6	-0.91272E-01	1.15893	6.2568	-0.16368	0.04507	0.48368
7	-0.16243	0.42259	6.6360	-0.12368	0.06766	0.52368
8	-0.11050	-0.07833	7.0152	-0.08368	0.07812	0.56368
9	-0.14068	-0.71606	7.3944	-0.04368	0.09506	0.60368
10	-0.15054	-1.39848	7.7736	-0.00368	0.11447	0.64368
11	-0.18445E-01	-1.48209	8.1528	0.03632	0.11476	0.68368
12	0.12427	-0.91877	8.5320	0.07632	0.12798	0.72368
13	-0.85418E-01	-1.30599	8.9112	0.11632	0.13423	0.76368
14	0.22815	-0.27176	9.2904	0.15632	0.17879	0.80368
15	-0.66407E-01	-0.57279	9.6696	0.19632	0.18257	0.84368
16	-0.27981	-1.84121	10.0488	0.23632	0.24960	0.88368
17	-0.25868	-3.01387	10.4280	0.27632	0.30690	0.92368
18	-0.15685	-3.72488	10.8072	0.31632	0.32796	0.96368
19	-0.88801E-02	-3.76514	11.1864	0.35632	0.32803	1.00368
20	-0.31974	-5.21456	11.5656	0.39632	0.41556	1.04368
21	0.32351	-3.74803	11.9448	0.43632	0.50517	1.08368
22	-0.92331E-01	-4.16658	12.3240	0.47632	0.51247	1.12368
23	0.33308	-2.65665	12.7032	0.51632	0.60746	1.16368
24	-0.29428	-3.99065	13.0824	0.55632	0.68161	1.20368
25	0.99762E-01	-3.53841	13.4616	0.59632	0.69013	1.24368
26	0.17248	-2.75655	13.8408	0.63632	0.71560	1.28368
27	0.57633	-0.14393	14.2200	0.67632	1.00000	1.32368

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = -0.0288 WITH 24 D.F.

HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 5.8704 WITH M = 8

APPENDIX K

CUSUM TEST
(continued)

```
 OLS ESTIMATION
       27 OBSERVATIONS     DEPENDENT VARIABLE = LNACCRAT
DURBIN-WATSON STATISTIC  =    1.80983
DURBIN-WATSON PROBABILITY =    0.236618
 R-SQUARE =    0.9172     R-SQUARE ADJUSTED =    0.9138
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.46718E-01
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.21614
 SUM OF SQUARED ERRORS-SSE=   1.1679
 MEAN OF DEPENDENT VARIABLE =   1.7485
 LOG OF THE LIKELIHOOD FUNCTION =  4.08665
VARIABLE    ESTIMATED   STANDARD   T-RATIO    PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT    ERROR      25 DF      CORR.  COEFFICIENT  AT MEANS
 YEAR     -0.88846E-01 0.53405E-02  -16.636    -0.9577 -0.95768      -3.7601
 CONSTANT   8.3231      0.39738      20.945     0.9727  0.00000       4.7601

 REQUIRED MEMORY IS PAR=    6 CURRENT PAR=  500
 DEPENDENT VARIABLE = LNACCRAT        27 OBSERVATIONS
 REGRESSION COEFFICIENTS
  -0.888459968996E-01   8.32313497880
 RECURSIVE COEFFICIENT ESTIMATES
    2 -0.29379       20.815
    3 -0.93409E-01   8.5249
    4 -0.32652E-01   4.7782
    5 -0.97589E-02   3.3588
    6 -0.28654E-01   4.5366
    7 -0.52432E-01   6.0267
    8 -0.64489E-01   6.7862
    9 -0.76378E-01   7.5393
   10 -0.86528E-01   8.1854
   11 -0.87543E-01   8.2504
   12 -0.81851E-01   7.8842
   13 -0.85158E-01   8.0981
   14 -0.77595E-01   7.6065
   15 -0.79501E-01   7.7310
   16 -0.86526E-01   8.1923
   17 -0.92253E-01   8.5703
   18 -0.95339E-01   8.7750
   19 -0.95495E-01   8.7854
   20 -0.10056       9.1245
   21 -0.95924E-01   8.8126
   22 -0.97126E-01   8.8939
   23 -0.93168E-01   8.6248
   24 -0.96373E-01   8.8438
   25 -0.95374E-01   8.7752
   26 -0.93779E-01   8.6652
   27 -0.88846E-01   8.3231
```

APPENDIX K

CUSUM TEST
(continued)

RECURSIVE RESIDUALS - SIGNIFICANCE LEVEL =10%

OBS	REC-RES	CUSUM	BOUND	LOWER	CUSUMSQ	UPPER
3	0.16361	0.74166	4.5900	-0.24771	0.02292	0.32771
4	0.11093	1.24450	4.9300	-0.20771	0.03345	0.36771
5	0.72396E-01	1.57268	5.2700	-0.16771	0.03794	0.40771
6	-0.91272E-01	1.15893	5.6100	-0.12771	0.04507	0.44771
7	-0.16243	0.42259	5.9500	-0.08771	0.06766	0.48771
8	-0.11050	-0.07833	6.2900	-0.04771	0.07812	0.52771
9	-0.14068	-0.71606	6.6300	-0.00771	0.09506	0.56771
10	-0.15054	-1.39848	6.9700	0.03229	0.11447	0.60771
11	-0.18445E-01	-1.48209	7.3100	0.07229	0.11476	0.64771
12	0.12427	-0.91877	7.6500	0.11229	0.12798	0.68771
13	-0.85418E-01	-1.30599	7.9900	0.15229	0.13423	0.72771
14	0.22815	-0.27176	8.3300	0.19229	0.17879	0.76771
15	-0.66407E-01	-0.57279	8.6700	0.23229	0.18257	0.80771
16	-0.27981	-1.84121	9.0100	0.27229	0.24960	0.84771
17	-0.25868	-3.01387	9.3500	0.31229	0.30690	0.88771
18	-0.15685	-3.72488	9.6900	0.35229	0.32796	0.92771
19	-0.88801E-02	-3.76514	10.0300	0.39229	0.32803	0.96771
20	-0.31974	-5.21456	10.3700	0.43229	0.41556	1.00771
21	0.32351	-3.74803	10.7100	0.47229	0.50517	1.04771
22	-0.92331E-01	-4.16658	11.0500	0.51229	0.51247	1.08771
23	0.33308	-2.65665	11.3900	0.55229	0.60746	1.12771
24	-0.29428	-3.99065	11.7300	0.59229	0.68161	1.16771
25	0.99762E-01	-3.53841	12.0700	0.63229	0.69013	1.20771
26	0.17248	-2.75655	12.4100	0.67229	0.71560	1.24771
27	0.57633	-0.14393	12.7500	0.71229	1.00000	1.28771

HARVEY(1981,EQUATION 2.10 RECURSIVE T-TEST = -0.0288 WITH 24 D.F.
HARVEY(1981,EQUATION 2.12 HETEROSKEDASTICITY TEST = 5.8704 WITH M = 8

ALL VARIABLES HAVE BEEN DELETED

APPENDIX L

RUNNING DEREGULATION DUMMY

APPENDIX L

RUNNING DEREGULATION DUMMY

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\agr.doc
sample 1 200
read(11) airline year d totocc y n u hours


* generate controllable rate
genr  ocrate     =  (1000000*(y+1))/hours


* generate log of the controllable rate
genr  lnocrate  =  log(ocrate)

print year  y hours ocrate lnocrate

*generate dummy for deregulation
genr  d          =  dum(year - 74.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 74)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum

*generate dummy for deregulation
genr  d          =  dum(year - 75.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 75)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum
```

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

```
*generate dummy for deregulation
genr  d          =  dum(year - 76.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 76)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year    timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 77.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 77)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year    timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 78.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 78)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year    timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum
```

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

```
*generate dummy for deregulation
genr  d          =  dum(year - 79.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 79)
print year d timedum

pool lnocrate year                /ncross=8
pool lnocrate year  d             /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 80.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 80)
print year d timedum

pool lnocrate year                /ncross=8
pool lnocrate year  d             /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 81.9)
*generate time since deregulation dummy
genr  timedum    =  d*(year - 81)
print year d timedum

pool lnocrate year                /ncross=8
pool lnocrate year  d             /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum
```

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

```
*generate dummy for deregulation
genr  d          =  dum(year - 82.9)
*generate time since deregulation dummy
genr  timedum   =  d*(year - 82)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 83.9)
*generate time since deregulation dummy
genr  timedum   =  d*(year - 83)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum


*generate dummy for deregulation
genr  d          =  dum(year - 84.9)
*generate time since deregulation dummy
genr  timedum   =  d*(year - 84)
print year d timedum

pool lnocrate year              /ncross=8
pool lnocrate year  d           /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  d
delete  timedum
```

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\agr.doc

8 VARIABLES AND 200 OBSERVATIONS STARTING AT OBS 1

YEAR	Y	HOURS	OCRATE	LNOCRATE
64.00000	7.000000	363437.0	22.01207	3.091591
65.00000	8.000000	391523.0	22.98716	3.134936
66.00000	7.000000	453253.0	17.65019	2.870746
67.00000	3.000000	541077.0	7.392663	2.000488
68.00000	6.000000	618650.0	11.31496	2.426126
69.00000	1.000000	637328.0	3.138102	1.143618
70.00000	6.000000	671977.0	10.41702	2.343441
71.00000	10.00000	658728.0	16.69885	2.815340
72.00000	4.000000	642511.0	7.781968	2.051809
73.00000	7.000000	661120.0	12.10068	2.493261
74.00000	6.000000	614117.0	11.39848	2.433480
75.00000	6.000000	629924.0	11.11245	2.408066
76.00000	3.000000	656110.0	6.096539	1.807721
77.00000	4.000000	671540.0	7.445573	2.007620
78.00000	4.000000	688255.0	7.264749	1.983034
79.00000	4.000000	747748.0	6.686745	1.900127
80.00000	0.0000000	693604.0	1.441745	0.3658541
81.00000	3.000000	610468.0	6.552350	1.879824
82.00000	3.000000	619230.0	6.459635	1.865573
83.00000	6.000000	658990.0	10.62232	2.362957
84.00000	5.000000	749857.0	8.001526	2.079632
85.00000	9.000000	858870.0	11.64321	2.454723
86.00000	4.000000	946058.0	5.285088	1.664889
87.00000	6.000000	1168616.	5.989992	1.790090
88.00000	9.000000	1337015.	7.479348	2.012146
64.00000	0.0000000	77582.00	12.88959	2.556420
65.00000	2.000000	93043.00	32.24316	3.473306
66.00000	2.000000	115295.0	26.02021	3.258874
67.00000	1.000000	135369.0	14.77443	2.692898
68.00000	0.0000000	167193.0	5.981112	1.788606
69.00000	1.000000	194493.0	10.28315	2.330506
70.00000	1.000000	194732.0	10.27053	2.329278
71.00000	2.000000	199498.0	15.03774	2.710563
72.00000	1.000000	195942.0	10.20710	2.323084
73.00000	0.0000000	182774.0	5.471238	1.699505
74.00000	0.0000000	168444.0	5.936691	1.781152
75.00000	2.000000	175720.0	17.07262	2.837476
76.00000	3.000000	163492.0	24.46603	3.197286
77.00000	1.000000	186494.0	10.72421	2.372503
78.00000	1.000000	210545.0	9.499157	2.251203
79.00000	1.000000	240802.0	8.305579	2.116927

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

80.00000	1.000000	198611.0	10.06994	2.309554
81.00000	2.000000	200482.0	14.96394	2.705643
82.00000	2.000000	231456.0	12.96143	2.561978
83.00000	6.000000	241362.0	29.00208	3.367368
84.00000	1.000000	260119.0	7.688789	2.039763
85.00000	0.0000000	375422.0	2.663669	0.9797046
86.00000	2.000000	493447.0	6.079680	1.804952
87.00000	5.000000	959845.0	6.251009	1.832743
88.00000	2.000000	967692.0	3.100160	1.131454
64.00000	5.000000	215521.0	27.83951	3.326456
65.00000	1.000000	233057.0	8.581592	2.149619
66.00000	7.000000	263519.0	30.35834	3.413071
67.00000	3.000000	288875.0	13.84682	2.628056
68.00000	2.000000	319499.0	9.389701	2.239613
69.00000	9.000000	373621.0	26.76509	3.287098
70.00000	3.000000	423060.0	9.454924	2.246536
71.00000	4.000000	430775.0	11.60699	2.451607
72.00000	8.000000	484794.0	18.56459	2.921256
73.00000	7.000000	560178.0	14.28117	2.658942
74.00000	7.000000	509258.0	15.70913	2.754242
75.00000	6.000000	512431.0	13.66038	2.614499
76.00000	4.000000	535971.0	9.328863	2.233113
77.00000	3.000000	558720.0	7.159221	1.968401
78.00000	4.000000	601411.0	8.313782	2.117915
79.00000	1.000000	642041.0	3.115066	1.136250
80.00000	2.000000	661567.0	4.534688	1.511756
81.00000	3.000000	665432.0	6.011133	1.793613
82.00000	0.0000000	649484.0	1.539684	0.4315771
83.00000	0.0000000	666098.0	1.501281	0.4063185
84.00000	2.000000	706422.0	4.246753	1.446155
85.00000	7.000000	740387.0	10.80516	2.380024
86.00000	1.000000	742440.0	2.693820	0.9909604
87.00000	6.000000	1064383.	6.576580	1.883515
88.00000	6.000000	1198156.	5.842311	1.765126
64.00000	17.00000	402847.0	44.68198	3.799570
65.00000	12.00000	417634.0	31.12773	3.438099
66.00000	10.00000	365461.0	30.09897	3.404491
67.00000	11.00000	486056.0	24.68851	3.206338
68.00000	7.000000	545801.0	14.65736	2.684942
69.00000	10.00000	612663.0	17.95441	2.887836
70.00000	5.000000	624845.0	9.602381	2.262011
71.00000	5.000000	636749.0	9.422865	2.243139
72.00000	9.000000	653285.0	15.30725	2.728327
73.00000	7.000000	684308.0	11.69064	2.458789
74.00000	5.000000	600699.0	9.988364	2.301421
75.00000	7.000000	641077.0	12.47900	2.524047
76.00000	3.000000	664828.0	6.016594	1.794521

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

77.00000	4.000000	680945.0	7.342737	1.993712
78.00000	3.000000	692122.0	5.779328	1.754287
79.00000	2.000000	725991.0	4.132283	1.418830
80.00000	2.000000	737661.0	4.066909	1.402883
81.00000	7.000000	711985.0	11.23619	2.419140
82.00000	3.000000	681472.0	5.869647	1.769794
83.00000	4.000000	711994.0	7.022531	1.949124
84.00000	4.000000	770245.0	6.491441	1.870485
85.00000	4.000000	787921.0	6.345814	1.847795
86.00000	8.000000	813770.0	11.05964	2.403302
87.00000	7.000000	786767.0	10.16819	2.319265
88.00000	3.000000	666009.0	6.005925	1.792746
64.00000	5.000000	147961.0	40.55123	3.702566
65.00000	2.000000	170434.0	17.60212	2.868019
66.00000	0.0000000	187125.0	5.344021	1.675978
67.00000	1.000000	250665.0	7.978776	2.076785
68.00000	4.000000	286372.0	17.45981	2.859902
69.00000	0.0000000	319600.0	3.128911	1.140685
70.00000	1.000000	204446.0	9.782534	2.280599
71.00000	6.000000	250879.0	27.90190	3.328695
72.00000	4.000000	195560.0	25.56760	3.241326
73.00000	2.000000	266220.0	11.26888	2.422045
74.00000	1.000000	254621.0	7.854812	2.061126
75.00000	1.000000	247597.0	8.077642	2.089100
76.00000	0.0000000	256599.0	3.897131	1.360241
77.00000	1.000000	261980.0	7.634171	2.032634
78.00000	0.0000000	154584.0	6.468975	1.867018
79.00000	0.0000000	266743.0	3.748927	1.321470
80.00000	0.0000000	275163.0	3.634210	1.290392
81.00000	5.000000	272648.0	22.00640	3.091333
82.00000	0.0000000	268219.0	3.728297	1.315951
83.00000	1.000000	300621.0	6.652895	1.895052
84.00000	3.000000	320482.0	12.48120	2.524224
85.00000	2.000000	357120.0	8.400538	2.128296
86.00000	1.000000	508201.0	3.935451	1.370025
87.00000	3.000000	835486.0	4.787633	1.566036
88.00000	7.000000	824055.0	9.708090	2.272960
64.00000	8.000000	287792.0	31.27259	3.442742
65.00000	5.000000	320997.0	18.69176	2.928083
66.00000	4.000000	385718.0	12.96284	2.562087
67.00000	6.000000	466942.0	14.99116	2.707460
68.00000	6.000000	534702.0	13.09140	2.571956
69.00000	7.000000	540925.0	14.78948	2.693916
70.00000	9.000000	485437.0	20.60000	3.025291
71.00000	6.000000	457327.0	15.30633	2.728267
72.00000	2.000000	447615.0	6.702188	1.902434
73.00000	2.000000	471282.0	6.365615	1.850911

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

74.00000	4.000000	417062.0	11.98863	2.483958
75.00000	2.000000	363570.0	8.251506	2.110396
76.00000	0.0000000	327247.0	3.055796	1.117040
77.00000	1.000000	309192.0	6.468473	1.866940
78.00000	1.000000	293047.0	6.824844	1.920569
79.00000	3.000000	292298.0	13.68466	2.616276
80.00000	0.0000000	439569.0	2.274956	0.8219606
81.00000	3.000000	398513.0	10.03731	2.306310
82.00000	2.000000	410173.0	7.313987	1.989789
83.00000	2.000000	373584.0	8.030322	2.083225
84.00000	1.000000	353951.0	5.650500	1.731744
85.00000	0.0000000	331888.0	3.013065	1.102958
86.00000	2.000000	285804.0	10.49670	2.351061
87.00000	2.000000	312630.0	9.596008	2.261347
88.00000	2.000000	364257.0	8.235943	2.108508
64.00000	8.000000	348781.0	25.80416	3.250536
65.00000	6.000000	403289.0	17.35728	2.854012
66.00000	4.000000	412011.0	12.13560	2.496143
67.00000	6.000000	528992.0	13.23271	2.582692
68.00000	5.000000	621522.0	9.653721	2.267343
69.00000	7.000000	694349.0	11.52158	2.444222
70.00000	8.000000	703858.0	12.78667	2.548403
71.00000	5.000000	674630.0	8.893764	2.185350
72.00000	8.000000	674010.0	13.35292	2.591735
73.00000	2.000000	612358.0	4.899095	1.589050
74.00000	7.000000	614961.0	13.00896	2.565638
75.00000	7.000000	597666.0	13.38540	2.594165
76.00000	0.0000000	608024.0	1.644672	0.4975409
77.00000	2.000000	617284.0	4.860000	1.581038
78.00000	1.000000	600007.0	3.333294	1.203961
79.00000	2.000000	599199.0	5.006684	1.610774
80.00000	1.000000	512270.0	3.904191	1.362051
81.00000	1.000000	432053.0	4.629062	1.532354
82.00000	3.000000	396721.0	10.08265	2.310816
83.00000	5.000000	411915.0	14.56611	2.678698
84.00000	1.000000	441134.0	4.533770	1.511554
85.00000	1.000000	466360.0	4.288532	1.455945
86.00000	3.000000	478444.0	8.360435	2.123510
87.00000	2.000000	570382.0	5.259633	1.660061
88.00000	1.000000	607679.0	3.291211	1.191256
64.00000	14.00000	597264.0	25.11452	3.223446
65.00000	9.000000	661152.0	15.12511	2.716357
66.00000	11.00000	636788.0	18.84458	2.936225
67.00000	17.00000	809078.0	22.24755	3.102232
68.00000	13.00000	922099.0	15.18275	2.720160
69.00000	9.000000	963734.0	10.37631	2.339525
70.00000	11.00000	986351.0	12.16605	2.498650

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

71.00000	10.00000	916048.0	12.00810	2.485582
72.00000	4.000000	910516.0	5.491392	1.703182
73.00000	3.000000	908331.0	4.403681	1.482441
74.00000	4.000000	818425.0	6.109295	1.809811
75.00000	5.000000	768504.0	7.807376	2.055069
76.00000	1.000000	811798.0	2.463667	0.9016509
77.00000	4.000000	849573.0	5.885309	1.772459
78.00000	6.000000	926468.0	7.555577	2.022286
79.00000	1.000000	814627.0	2.455111	0.8981721
80.00000	3.000000	920898.0	4.343586	1.468700
81.00000	3.000000	758373.0	5.274449	1.662874
82.00000	2.000000	760207.0	3.946294	1.372777
83.00000	8.000000	833093.0	10.80312	2.379835
84.00000	7.000000	945600.0	8.460237	2.135377
85.00000	2.000000	826534.0	3.629615	1.289127
86.00000	5.000000	1121721.	5.348924	1.676895
87.00000	5.000000	1222937.	4.906222	1.590504
88.00000	3.000000	1201883.	3.328111	1.202405

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	1.000000	1.000000
76.00000	1.000000	2.000000
77.00000	1.000000	3.000000
78.00000	1.000000	4.000000
79.00000	1.000000	5.000000
80.00000	1.000000	6.000000
81.00000	1.000000	7.000000
82.00000	1.000000	8.000000
83.00000	1.000000	9.000000
84.00000	1.000000	10.00000
85.00000	1.000000	11.00000
86.00000	1.000000	12.00000
87.00000	1.000000	13.00000
88.00000	1.000000	14.00000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.2880 BUSE RAW-MOMENT R-SQUARE = 0.9242
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89296
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94497
SUM OF SQUARED ERRORS-SSE= 175.91
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.295

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.40225E-01	0.11131E-01	-3.6137	-0.2493	-0.43596	-1.4138
D	-0.22946	0.16000	-1.4341	-0.1016	-0.17119	-0.59424E-01
CONSTANT	5.3401	0.77392	6.9001	0.4412	0.00000	2.4696

BUSE R-SQUARE = 0.3632 BUSE RAW-MOMENT R-SQUARE = 0.9365
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89091
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94388
SUM OF SQUARED ERRORS-SSE= 175.51
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -142.280

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11659	0.15224E-01	-7.6582	-0.4790	-1.2636	-4.0977
TIMEDUM	0.10201	0.22938E-01	4.4470	0.3020	0.73462	0.19813
CONSTANT	10.583	1.0679	9.9099	0.5768	0.00000	4.8940

BUSE R-SQUARE = 0.3852 BUSE RAW-MOMENT R-SQUARE = 0.9414
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85446
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92437
SUM OF SQUARED ERRORS-SSE= 167.47
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -141.425

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10263	0.17904E-01	-5.7320	-0.3789	-1.1123	-3.6070
D	-0.20777	0.14658	-1.4175	-0.1007	-0.15501	-0.53808E-01
TIMEDUM	0.99267E-01	0.22301E-01	4.4512	0.3030	0.71490	0.19281
CONSTANT	9.6489	1.2374	7.7976	0.4866	0.00000	4.4622

APPENDIX L

RUNNING DEREGULATION DUMMY (continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	1.000000	1.000000
77.00000	1.000000	2.000000
78.00000	1.000000	3.000000
79.00000	1.000000	4.000000
80.00000	1.000000	5.000000
81.00000	1.000000	6.000000
82.00000	1.000000	7.000000
83.00000	1.000000	8.000000
84.00000	1.000000	9.000000
85.00000	1.000000	10.00000
86.00000	1.000000	11.00000
87.00000	1.000000	12.00000
88.00000	1.000000	13.00000

APPENDIX L

RUNNING DEREGULATION DUMMY (continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3130 BUSE RAW-MOMENT R-SQUARE = 0.9231
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89294
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94496
SUM OF SQUARED ERRORS-SSE= 175.91
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -144.774

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.22488E-01	0.11219E-01	-2.0045	-0.1414	-0.24373	-0.79039
D	-0.53954	0.15983	-3.3758	-0.2338	-0.40513	-0.12975
CONSTANT	4.1440	0.78568	5.2744	0.3518	0.00000	1.9164

BUSE R-SQUARE = 0.3761 BUSE RAW-MOMENT R-SQUARE = 0.9392
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89088
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94386
SUM OF SQUARED ERRORS-SSE= 175.50
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -141.639

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11119	0.13380E-01	-8.3105	-0.5095	-1.2051	-3.9081
TIMEDUM	0.10306	0.21846E-01	4.7175	0.3186	0.68418	0.17348
CONSTANT	10.226	0.94498	10.821	0.6106	0.00000	4.7289

BUSE R-SQUARE = 0.4214 BUSE RAW-MOMENT R-SQUARE = 0.9448
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85402
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92413
SUM OF SQUARED ERRORS-SSE= 167.39
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -135.972

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.81506E-01	0.15290E-01	-5.3308	-0.3558	-0.88338	-2.8647
D	-0.50531	0.14258	-3.5441	-0.2454	-0.37943	-0.12152
TIMEDUM	0.10350	0.20888E-01	4.9549	0.3336	0.68710	0.17422
CONSTANT	8.2307	1.0646	7.7312	0.4834	0.00000	3.8063

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	1.000000	1.000000
78.00000	1.000000	2.000000
79.00000	1.000000	3.000000
80.00000	1.000000	4.000000
81.00000	1.000000	5.000000
82.00000	1.000000	6.000000
83.00000	1.000000	7.000000
84.00000	1.000000	8.000000
85.00000	1.000000	9.000000
86.00000	1.000000	10.00000
87.00000	1.000000	11.00000
88.00000	1.000000	12.00000

APPENDIX L

RUNNING DEREGULATION DUMMY (continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.2654 BUSE RAW-MOMENT R-SQUARE = 0.9170
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89244
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94469
SUM OF SQUARED ERRORS-SSE= 175.81
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.817

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.57361E-01	0.11619E-01	-4.9366	-0.3318	-0.62169	-2.0161
D	0.63198E-01	0.16554	0.38177	0.0272	0.47455E-01	0.14029E-01
CONSTANT	6.4879	0.81906	7.9211	0.4915	0.00000	3.0004

BUSE R-SQUARE = 0.3975 BUSE RAW-MOMENT R-SQUARE = 0.9422
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89049
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94366
SUM OF SQUARED ERRORS-SSE= 175.43
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.473

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10975	0.11817E-01	-9.2877	-0.5518	-1.1895	-3.8575
TIMEDUM	0.11231	0.21108E-01	5.3209	0.3545	0.68081	0.16206
CONSTANT	10.141	0.84013	12.071	0.6520	0.00000	4.6897

BUSE R-SQUARE = 0.4042 BUSE RAW-MOMENT R-SQUARE = 0.9438
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85363
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92392
SUM OF SQUARED ERRORS-SSE= 167.31
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.439

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10622	0.13759E-01	-7.7205	-0.4829	-1.1513	-3.7334
D	-0.69645E-01	0.14603	-0.47692	-0.0340	-0.52296E-01	-0.15460E-01
TIMEDUM	0.11343	0.21099E-01	5.3761	0.3585	0.68757	0.16366
CONSTANT	9.9030	0.96502	10.262	0.5912	0.00000	4.5797

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	1.000000	1.000000
79.00000	1.000000	2.000000
80.00000	1.000000	3.000000
81.00000	1.000000	4.000000
82.00000	1.000000	5.000000
83.00000	1.000000	6.000000
84.00000	1.000000	7.000000
85.00000	1.000000	8.000000
86.00000	1.000000	9.000000
87.00000	1.000000	10.00000
88.00000	1.000000	11.00000

APPENDIX L

RUNNING DEREGULATION DUMMY (continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.2642 BUSE RAW-MOMENT R-SQUARE = 0.9169
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89284
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94490
SUM OF SQUARED ERRORS-SSE= 175.89
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.716

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.58939E-01	0.11448E-01	-5.1485	-0.3444	-0.63879	-2.0715
D	0.94393E-01	0.16400	0.57556	0.0410	0.70423E-01	0.19207E-01
CONSTANT	6.5970	0.81225	8.1219	0.5008	0.00000	3.0508

BUSE R-SQUARE = 0.4027 BUSE RAW-MOMENT R-SQUARE = 0.9435
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89090
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94387
SUM OF SQUARED ERRORS-SSE= 175.51
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.476

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10361	0.10682E-01	-9.6996	-0.5685	-1.1229	-3.6415
TIMEDUM	0.11343	0.21101E-01	5.3758	0.3577	0.62105	0.13849
CONSTANT	9.7251	0.76428	12.724	0.6717	0.00000	4.4974

BUSE R-SQUARE = 0.4029 BUSE RAW-MOMENT R-SQUARE = 0.9434
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85436
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92431
SUM OF SQUARED ERRORS-SSE= 167.45
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.482

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10114	0.12385E-01	-8.1666	-0.5039	-1.0962	-3.5549
D	-0.56520E-01	0.14877	-0.37993	-0.0271	-0.42168E-01	-0.11501E-01
TIMEDUM	0.11499	0.21950E-01	5.2387	0.3505	0.62958	0.14039
CONSTANT	9.5598	0.87506	10.925	0.6152	0.00000	4.4210

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	1.000000	1.000000
80.00000	1.000000	2.000000
81.00000	1.000000	3.000000
82.00000	1.000000	4.000000
83.00000	1.000000	5.000000
84.00000	1.000000	6.000000
85.00000	1.000000	7.000000
86.00000	1.000000	8.000000
87.00000	1.000000	9.000000
88.00000	1.000000	10.00000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.2695 BUSE RAW-MOMENT R-SQUARE = 0.9189
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89292
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94494
SUM OF SQUARED ERRORS-SSE= 175.90
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.718

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.60065E-01	0.11043E-01	-5.4390	-0.3613	-0.65099	-2.1111
D	0.11700	0.16029	0.72996	0.0519	0.86151E-01	0.21644E-01
CONSTANT	6.6754	0.78853	8.4657	0.5165	0.00000	3.0871

BUSE R-SQUARE = 0.4025 BUSE RAW-MOMENT R-SQUARE = 0.9434
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89110
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94398
SUM OF SQUARED ERRORS-SSE= 175.55
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.557

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.98116E-01	0.98341E-02	-9.9772	-0.5794	-1.0634	-3.4485
TIMEDUM	0.11611	0.21744E-01	5.3398	0.3556	0.56710	0.11813
CONSTANT	9.3529	0.70801	13.210	0.6854	0.00000	4.3253

BUSE R-SQUARE = 0.4018 BUSE RAW-MOMENT R-SQUARE = 0.9430
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85474
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92452
SUM OF SQUARED ERRORS-SSE= 167.53
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.344

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.93809E-01	0.11227E-01	-8.3554	-0.5125	-1.0167	-3.2971
D	-0.11816	0.15236	-0.77556	-0.0553	-0.87004E-01	-0.21858E-01
TIMEDUM	0.12224	0.23625E-01	5.1741	0.3467	0.59703	0.12437
CONSTANT	9.0609	0.79906	11.339	0.6294	0.00000	4.1903

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	1.000000	1.000000
81.00000	1.000000	2.000000
82.00000	1.000000	3.000000
83.00000	1.000000	4.000000
84.00000	1.000000	5.000000
85.00000	1.000000	6.000000
86.00000	1.000000	7.000000
87.00000	1.000000	8.000000
88.00000	1.000000	9.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3046 BUSE RAW-MOMENT R-SQUARE = 0.9277
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89256
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94476
SUM OF SQUARED ERRORS-SSE= 175.84
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -147.425

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.74237E-01	0.10138E-01	-7.3227	-0.4626	-0.80459	-2.6092
D	0.38916	0.15032	2.5889	0.1814	0.28075	0.64789E-01
CONSTANT	7.6548	0.72833	10.510	0.5994	0.00000	3.5400

BUSE R-SQUARE = 0.4021 BUSE RAW-MOMENT R-SQUARE = 0.9431
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89128
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94408
SUM OF SQUARED ERRORS-SSE= 175.58
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.342

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.93619E-01	0.91204E-02	-10.265	-0.5903	-1.0147	-3.2904
TIMEDUM	0.12246	0.22893E-01	5.3490	0.3561	0.52575	0.10194
CONSTANT	9.0477	0.66061	13.696	0.6984	0.00000	4.1842

BUSE R-SQUARE = 0.4054 BUSE RAW-MOMENT R-SQUARE = 0.9438
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85495
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92463
SUM OF SQUARED ERRORS-SSE= 167.57
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.202

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.96067E-01	0.10142E-01	-9.4726	-0.5604	-1.0412	-3.3764
D	0.84415E-01	0.15607	0.54089	0.0386	0.60900E-01	0.14054E-01
TIMEDUM	0.11606	0.26028E-01	4.4589	0.3035	0.49828	0.96609E-01
CONSTANT	9.2142	0.72703	12.674	0.6711	0.00000	4.2612

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	0.0000000	0.0000000
81.00000	1.000000	1.000000
82.00000	1.000000	2.000000
83.00000	1.000000	3.000000
84.00000	1.000000	4.000000
85.00000	1.000000	5.000000
86.00000	1.000000	6.000000
87.00000	1.000000	7.000000
88.00000	1.000000	8.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.4168 BUSE RAW-MOMENT R-SQUARE = 0.9407
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89126
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94407
SUM OF SQUARED ERRORS-SSE= 175.58
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -133.799

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.97559E-01	0.87107E-02	-11.200	-0.6237	-1.0574	-3.4289
D	0.85397	0.13268	6.4362	0.4168	0.59872	0.12638
CONSTANT	9.2773	0.62998	14.726	0.7239	0.00000	4.2903

BUSE R-SQUARE = 0.3923 BUSE RAW-MOMENT R-SQUARE = 0.9413
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89154
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94421
SUM OF SQUARED ERRORS-SSE= 175.63
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -140.023

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.88379E-01	0.86145E-02	-10.259	-0.5901	-0.95787	-3.1062
TIMEDUM	0.12745	0.24955E-01	5.1074	0.3419	0.47258	0.84875E-01
CONSTANT	8.6873	0.62767	13.841	0.7021	0.00000	4.0175

BUSE R-SQUARE = 0.4450 BUSE RAW-MOMENT R-SQUARE = 0.9461
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85443
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92435
SUM OF SQUARED ERRORS-SSE= 167.47
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -132.131

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.10425	0.90115E-02	-11.568	-0.6370	-1.1298	-3.6639
D	0.66247	0.15627	4.2392	0.2898	0.46446	0.98037E-01
TIMEDUM	0.60054E-01	0.28904E-01	2.0777	0.1468	0.22268	0.39992E-01
CONSTANT	9.7640	0.65073	15.005	0.7312	0.00000	4.5154

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	0.0000000	0.0000000
81.00000	0.0000000	0.0000000
82.00000	1.000000	1.000000
83.00000	1.000000	2.000000
84.00000	1.000000	3.000000
85.00000	1.000000	4.000000
86.00000	1.000000	5.000000
87.00000	1.000000	6.000000
88.00000	1.000000	7.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3760 BUSE RAW-MOMENT R-SQUARE = 0.9424
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89138
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94413
SUM OF SQUARED ERRORS-SSE= 175.60
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -144.038

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.80760E-01	0.82711E-02	-9.7642	-0.5711	-0.87529	-2.8385
D	0.58100	0.13163	4.4140	0.3000	0.39208	0.75232E-01
CONSTANT	8.1183	0.60180	13.490	0.6930	0.00000	3.7544

BUSE R-SQUARE = 0.3649 BUSE RAW-MOMENT R-SQUARE = 0.9374
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89208
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94450
SUM OF SQUARED ERRORS-SSE= 175.74
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -143.048

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.80396E-01	0.83109E-02	-9.6735	-0.5675	-0.87134	-2.8256
TIMEDUM	0.12050	0.28353E-01	4.2500	0.2898	0.37753	0.62412E-01
CONSTANT	8.1299	0.60908	13.348	0.6891	0.00000	3.7597

BUSE R-SQUARE = 0.3940 BUSE RAW-MOMENT R-SQUARE = 0.9441
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85524
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92479
SUM OF SQUARED ERRORS-SSE= 167.63
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -141.895

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.85894E-01	0.85110E-02	-10.092	-0.5848	-0.93093	-3.0189
D	0.31583	0.17177	1.8387	0.1302	0.21313	0.40896E-01
TIMEDUM	0.79736E-01	0.35516E-01	2.2451	0.1583	0.24982	0.41299E-01
CONSTANT	8.4998	0.61889	13.734	0.7003	0.00000	3.9308

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	0.0000000	0.0000000
81.00000	0.0000000	0.0000000
82.00000	0.0000000	0.0000000
83.00000	1.000000	1.000000
84.00000	1.000000	2.000000
85.00000	1.000000	3.000000
86.00000	1.000000	4.000000
87.00000	1.000000	5.000000
88.00000	1.000000	6.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3771 BUSE RAW-MOMENT R-SQUARE = 0.9371
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89248
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94471
SUM OF SQUARED ERRORS-SSE= 175.82
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.758

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.82675E-01	0.80062E-02	-10.326	-0.5926	-0.89605	-2.9058
D	0.66459	0.13242	5.0187	0.3367	0.42660	0.73762E-01
CONSTANT	8.2685	0.58694	14.087	0.7084	0.00000	3.8238

BUSE R-SQUARE = 0.3476 BUSE RAW-MOMENT R-SQUARE = 0.9334
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89224
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94459
SUM OF SQUARED ERRORS-SSE= 175.77
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -144.117

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.75968E-01	0.80403E-02	-9.4484	-0.5584	-0.82335	-2.6700
TIMEDUM	0.12637	0.33085E-01	3.8195	0.2626	0.32535	0.49089E-01
CONSTANT	7.8232	0.59261	13.201	0.6851	0.00000	3.6179

BUSE R-SQUARE = 0.3792 BUSE RAW-MOMENT R-SQUARE = 0.9376
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85623
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92532
SUM OF SQUARED ERRORS-SSE= 167.82
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -139.654

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.83681E-01	0.82435E-02	-10.151	-0.5870	-0.90695	-2.9411
D	0.59825	0.18566	3.2223	0.2243	0.38402	0.66400E-01
TIMEDUM	0.22368E-01	0.44862E-01	0.49859	0.0356	0.57589E-01	0.86892E-02
CONSTANT	8.3434	0.60384	13.817	0.7024	0.00000	3.8585

APPENDIX L

RUNNING DEREGULATION DUMMY (continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	0.0000000	0.0000000
81.00000	0.0000000	0.0000000
82.00000	0.0000000	0.0000000
83.00000	0.0000000	0.0000000
84.00000	1.000000	1.000000
85.00000	1.000000	2.000000
86.00000	1.000000	3.000000
87.00000	1.000000	4.000000
88.00000	1.000000	5.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3255 BUSE RAW-MOMENT R-SQUARE = 0.9311
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89273
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94484
SUM OF SQUARED ERRORS-SSE= 175.87
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -146.961

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.69437E-01	0.78860E-02	-8.8050	-0.5314	-0.75257	-2.4405
D	0.39719	0.13821	2.8739	0.2006	0.23879	0.36737E-01
CONSTANT	7.3511	0.58214	12.628	0.6688	0.00000	3.3996

BUSE R-SQUARE = 0.3251 BUSE RAW-MOMENT R-SQUARE = 0.9297
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89243
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94469
SUM OF SQUARED ERRORS-SSE= 175.81
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -146.305

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.69827E-01	0.77715E-02	-8.9851	-0.5392	-0.75680	-2.4542
TIMEDUM	0.12118	0.39921E-01	3.0355	0.2114	0.24706	0.33625E-01
CONSTANT	7.3909	0.57607	12.830	0.6747	0.00000	3.4180

BUSE R-SQUARE = 0.3345 BUSE RAW-MOMENT R-SQUARE = 0.9322
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85613
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92527
SUM OF SQUARED ERRORS-SSE= 167.80
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -146.031

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.71826E-01	0.79984E-02	-8.9800	-0.5399	-0.77846	-2.5244
D	0.18253	0.20893	0.87366	0.0623	0.10974	0.16883E-01
TIMEDUM	0.82623E-01	0.59849E-01	1.3805	0.0981	0.16845	0.22926E-01
CONSTANT	7.5273	0.59004	12.757	0.6735	0.00000	3.4810

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

YEAR	D	TIMEDUM
64.00000	0.0000000	0.0000000
65.00000	0.0000000	0.0000000
66.00000	0.0000000	0.0000000
67.00000	0.0000000	0.0000000
68.00000	0.0000000	0.0000000
69.00000	0.0000000	0.0000000
70.00000	0.0000000	0.0000000
71.00000	0.0000000	0.0000000
72.00000	0.0000000	0.0000000
73.00000	0.0000000	0.0000000
74.00000	0.0000000	0.0000000
75.00000	0.0000000	0.0000000
76.00000	0.0000000	0.0000000
77.00000	0.0000000	0.0000000
78.00000	0.0000000	0.0000000
79.00000	0.0000000	0.0000000
80.00000	0.0000000	0.0000000
81.00000	0.0000000	0.0000000
82.00000	0.0000000	0.0000000
83.00000	0.0000000	0.0000000
84.00000	0.0000000	0.0000000
85.00000	1.000000	1.000000
86.00000	1.000000	2.000000
87.00000	1.000000	3.000000
88.00000	1.000000	4.000000

APPENDIX L

RUNNING DEREGULATION DUMMY
(continued)

DEPENDENT VARIABLE = LNOCRATE
BUSE R-SQUARE = 0.2632 BUSE RAW-MOMENT R-SQUARE = 0.9164
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.92896
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.96383
SUM OF SQUARED ERRORS-SSE= 183.93
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -149.873

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 198 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.53605E-01	0.63734E-02	-8.4109	-0.5131	-0.58098	-1.8841
CONSTANT	6.2333	0.48666	12.808	0.6731	0.00000	2.8827

BUSE R-SQUARE = 0.3101 BUSE RAW-MOMENT R-SQUARE = 0.9275
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89266
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94481
SUM OF SQUARED ERRORS-SSE= 175.85
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -147.852

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.65360E-01	0.75742E-02	-8.6293	-0.5237	-0.70839	-2.2972
D	0.33781	0.14245	2.3714	0.1666	0.18613	0.24995E-01
CONSTANT	7.0708	0.56307	12.558	0.6668	0.00000	3.2699

BUSE R-SQUARE = 0.3120 BUSE RAW-MOMENT R-SQUARE = 0.9270
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.89259
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.94477
SUM OF SQUARED ERRORS-SSE= 175.84
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -147.022

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 197 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.66242E-01	0.74730E-02	-8.8641	-0.5340	-0.71794	-2.3282
TIMEDUM	0.13406	0.50153E-01	2.6731	0.1871	0.20548	0.24799E-01
CONSTANT	7.1382	0.55709	12.813	0.6742	0.00000	3.3011

BUSE R-SQUARE = 0.3167 BUSE RAW-MOMENT R-SQUARE = 0.9283
VARIANCE OF THE ESTIMATE-SIGMA**2 = 0.85628
STANDARD ERROR OF THE ESTIMATE-SIGMA = 0.92536
SUM OF SQUARED ERRORS-SSE= 167.83
MEAN OF DEPENDENT VARIABLE = 2.1624
LOG OF THE LIKELIHOOD FUNCTION = -146.969

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 196 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.67099E-01	0.76558E-02	-8.7645	-0.5306	-0.72723	-2.3583
D	0.92117E-01	0.23372	0.39413	0.0281	0.50756E-01	0.68160E-02
TIMEDUM	0.10956	0.82186E-01	1.3331	0.0948	0.16793	0.20266E-01
CONSTANT	7.1984	0.56879	12.656	0.6706	0.00000	3.3290

APPENDIX M

NOT CONTROLLABLE

APPENDIX M

NOT CONTROLLABLE

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\tot.doc
sample 1 25
read(11) year d totocc y n u hours

* generate controlable rate
genr  ucrate    =  ((1000000*n))/hours

* generate log of the controlable rate
genr  lnucrate  =  log(ucrate)

* generate time since deregulation dummy
genr timedum   = d*(year - 79)
print n hours ucrate lnucrate year  timedum


ols   lncrate   year                  /exactdw
ols   lncrate   year  d               /exactdw
ols   lncrate   year     timedum      /exactdw
ols   lncrate   year  d  timedum      /exactdw

delete  / all
```

APPENDIX M

NOT CONTROLLABLE
(continued)

OUTPUT FILE

UNIT 11 IS NOW ASSIGNED TO: d:\shazam\d\f1\tot.doc

7 VARIABLES AND 25 OBSERVATIONS STARTING AT OBS 1

N	HOURS	UCRATE	LNUCRATE	YEAR	TIMEDUM
9	2441185.	3.686734	1.304741	64	0.00
11	2691129.	4.087504	1.407934	65	0.00
8	2819170.	2.837715	1.042999	66	0.00
10	3507054.	2.851396	1.047809	67	0.00
10	4015838.	2.490140	0.9123391	68	0.00
10	4336713.	2.305894	0.8354684	69	0.00
13	4294706.	3.026983	1.107566	70	0.00
14	4224634.	3.313897	1.198125	71	0.00
15	4204233.	3.567833	1.271958	72	0.00
8	4346571.	1.840531	0.6100543	73	0.00
14	3997587.	3.502113	1.253366	74	0.00
10	3936489.	2.540335	0.9322959	75	0.00
11	4024069.	2.733552	1.005602	76	0.00
6	4135728.	1.450772	0.3720961	77	0.00
7	4166439.	1.680092	0.5188484	78	0.00
5	4329449.	1.154881	0.1439976	79	0.00
2	4439343.	0.4505171	-0.7973592	80	1.0
4	4049954.	0.9876655	-0.1241116E-01	81	2.0
3	4016962.	0.7468331	-0.2919136	82	3.0
6	4197657.	1.429369	0.3572330	83	4.0
8	4547810.	1.759088	0.5647957	84	5.0
6	4744502.	1.264622	0.2347730	85	6.0
13	5389885.	2.411925	0.8804253	86	7.0
21	6921046.	3.034223	1.109956	87	8.0
22	7166746.	3.069733	1.121591	88	9.0

APPENDIX M

NOT CONTROLLABLE
(continued)

25 OBSERVATIONS DEPENDENT VARIABLE = LNUCRATE
DURBIN-WATSON STATISTIC = 0.79060
DURBIN-WATSON PROBABILITY = 0.000115
R-SQUARE = 0.2308 R-SQUARE ADJUSTED = 0.1973
SUM OF SQUARED ERRORS-SSE= 5.5919

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 23 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.35924E-01	0.13675E-01	-2.6269	-0.4804	-0.48040	-3.7643
CONSTANT	3.4555	1.0440	3.3098	0.5680	0.00000	4.7643

25 OBSERVATIONS DEPENDENT VARIABLE = LNUCRATE
DURBIN-WATSON STATISTIC = 0.71964
DURBIN-WATSON PROBABILITY = 0.000014
R-SQUARE = 0.2773 R-SQUARE ADJUSTED = 0.2116
SUM OF SQUARED ERRORS-SSE= 5.2538

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.11735E-01	0.24434E-01	-0.48029	-0.1019	-0.15693	-1.2297
D	-0.43673	0.36708	-1.1898	-0.2459	-0.38875	-0.21677
CONSTANT	1.7744	1.7513	1.0132	0.2111	0.00000	2.4465

25 OBSERVATIONS DEPENDENT VARIABLE = LNUCRATE
DURBIN-WATSON STATISTIC = 1.15914
DURBIN-WATSON PROBABILITY = 0.002978
R-SQUARE = 0.4995 R-SQUARE ADJUSTED = 0.4539
SUM OF SQUARED ERRORS-SSE= 3.6388

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 22 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.90554E-01	0.19493E-01	-4.6455	-0.7037	-1.2110	-9.4887
TIMEDUM	0.16909	0.49207E-01	3.4364	0.5910	0.89576	0.41965
CONSTANT	7.3030	1.4125	5.1703	0.7406	0.00000	10.069

25 OBSERVATIONS DEPENDENT VARIABLE = LNUCRATE
DURBIN-WATSON STATISTIC = 2.09847
DURBIN-WATSON PROBABILITY = 0.342895
R-SQUARE = 0.8036 R-SQUARE ADJUSTED = 0.7756
SUM OF SQUARED ERRORS-SSE= 1.4275

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 21 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YEAR	-0.52821E-01	0.14140E-01	-3.7356	-0.6318	-0.70636	-5.5349
D	-1.2927	0.22666	-5.7033	-0.7795	-1.1507	-0.64163
TIMEDUM	0.27391	0.36509E-01	7.5024	0.8534	1.4510	0.67977
CONSTANT	4.7121	1.0131	4.6511	0.7123	0.00000	6.4968

APPENDIX N

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE USING REVENUE PASSENGER MILES

APPENDIX N

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE AUTOREGRESSIVE USING REVENUE PASSENGER MILES

COMMAND FILE

```
FILE 11  d:\shazam\d\f1\agrrpm.doc
sample 1 200

read(11) airline year d totocc y n u hours rpm


* generate controllable rate
genr  ocrate    =  (1000000*(y+1))/rpm


* generate log of the controllable rate
genr  lnocrate  =  log(ocrate)


*generate time since deregulation dummy
genr  timedum   =  d*(year - 79)


pool lnocrate year                /ncross=8
pool lnocrate year  d             /ncross=8
pool lnocrate year     timedum /ncross=8
pool lnocrate year  d  timedum /ncross=8

delete  / all
```

APPENDIX N

POOLED CROSS-SECTIONALLY HETEROSKEDASTIC AND TIME-WISE

AUTOREGRESSIVE USING REVENUE PASSENGER MILES
(continued)

OUTPUT FILE

```
BUSE R-SQUARE = 0.4759      BUSE RAW-MOMENT R-SQUARE = 0.9956
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.92929
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.96400
 SUM OF SQUARED ERRORS-SSE=   184.00
 MEAN OF DEPENDENT VARIABLE =    12.471
 LOG OF THE LIKELIHOOD FUNCTION = -165.030
VARIABLE    ESTIMATED   STANDARD   T-RATIO     PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR     198 DF       CORR.  COEFFICIENT  AT MEANS
YEAR     -0.10552     0.78697E-02  -13.408     -0.6898 -0.78207     -0.64304
 CONSTANT   20.455      0.60102       34.034      0.9241  0.00000       1.6403

BUSE R-SQUARE = 0.5091      BUSE RAW-MOMENT R-SQUARE = 0.9961
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89308
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.94503
 SUM OF SQUARED ERRORS-SSE=   175.94
 LOG OF THE LIKELIHOOD FUNCTION = -163.487
VARIABLE    ESTIMATED   STANDARD   T-RATIO     PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR     197 DF       CORR.  COEFFICIENT  AT MEANS
YEAR     -0.12412     0.12084E-01  -10.271     -0.5906 -0.91997     -0.75642
 D          0.35330     0.17656       2.0010      0.1411  0.17431       0.10199E-01
 CONSTANT   21.719      0.87023       24.958      0.8716  0.00000       1.7416

BUSE R-SQUARE = 0.6223      BUSE RAW-MOMENT R-SQUARE = 0.9973
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89288
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.94493
 SUM OF SQUARED ERRORS-SSE=   175.90
 LOG OF THE LIKELIHOOD FUNCTION = -150.636
VARIABLE    ESTIMATED   STANDARD   T-RATIO     PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR     197 DF       CORR.  COEFFICIENT  AT MEANS
YEAR     -0.15816     0.10717E-01  -14.758     -0.7246  -1.1723      -0.96386
 TIMEDUM    0.16144     0.26759E-01   6.0331      0.3949  0.47400       0.23302E-01
 CONSTANT   24.117      0.77592       31.082      0.9114  0.00000       1.9339

BUSE R-SQUARE = 0.6221      BUSE RAW-MOMENT R-SQUARE = 0.9973
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.85647
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.92546
 SUM OF SQUARED ERRORS-SSE=   167.87
 LOG OF THE LIKELIHOOD FUNCTION = -150.553
VARIABLE    ESTIMATED   STANDARD   T-RATIO     PARTIAL STANDARDIZED ELASTICITY
   NAME     COEFFICIENT    ERROR     196 DF       CORR.  COEFFICIENT  AT MEANS
YEAR     -0.15617     0.11849E-01  -13.180     -0.6855  -1.1576      -0.95177
 D        -0.62189E-01 0.17573      -0.35389    -0.0253 -0.30682E-01 -0.17952E-02
 TIMEDUM    0.16640     0.30232E-01   5.5041      0.3659  0.48857       0.24018E-01
 CONSTANT   23.979      0.84972       28.220      0.8958  0.00000       1.9228
```